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# missiles and rockets



- **Martin Tells Of ASP Concept**
- **\$500 Million For Moon Launch**
- **Latest Edition Of M/R Astrolog**

### First Ranger Launching

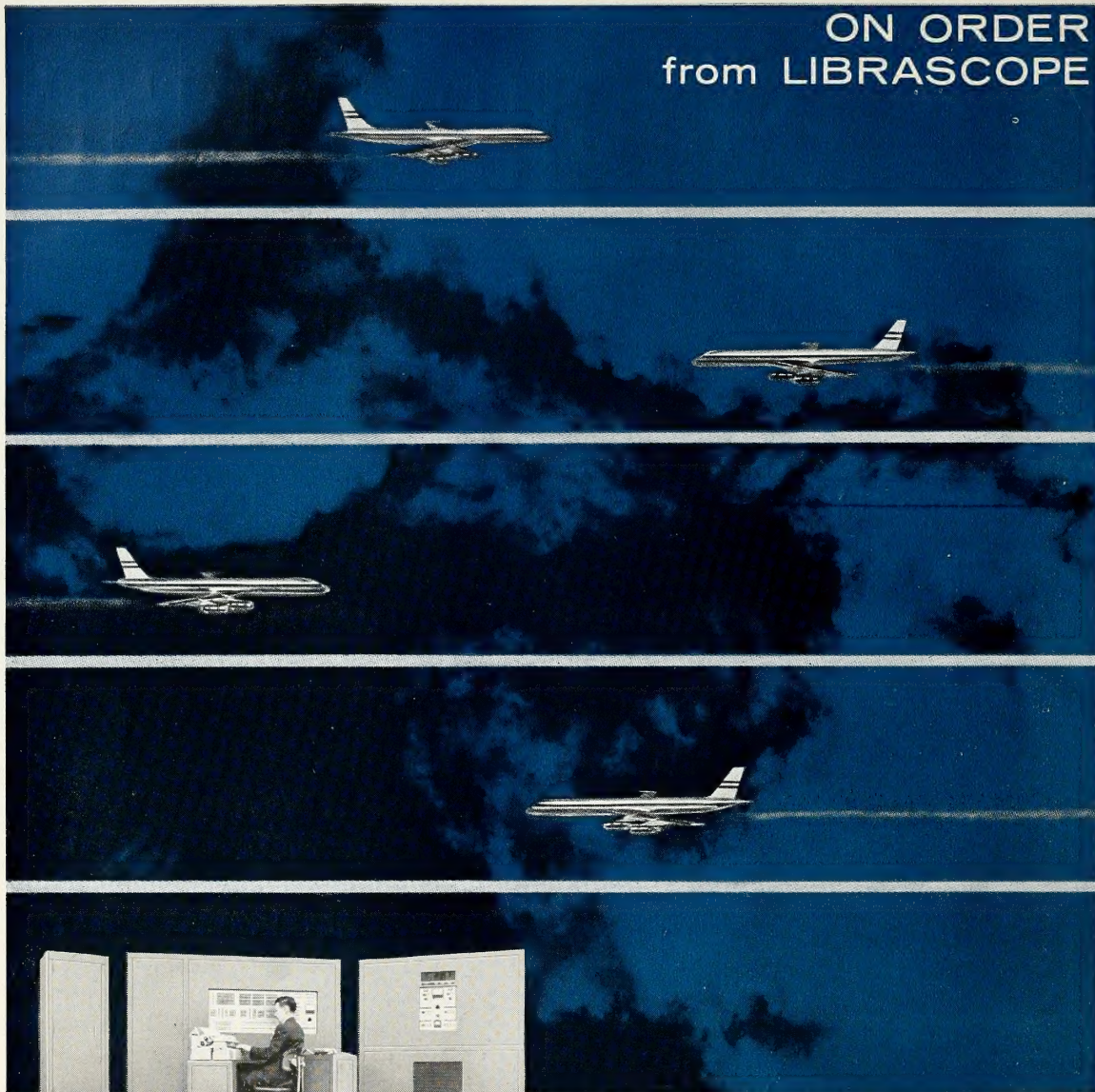
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## CENTRAL DATA PROCESSOR for AIR TRAFFIC CONTROL

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# CREATIVE CONTROVERSY IN INERTIAL GUIDANCE

Behind the inertial package you see here is the instructive history of a creative controversy.

It's the history of how the ingenious rebuttals of some Litton Systems people won an engineering debate by overcoming certain obstacles that had been roadblocking progress in airborne inertial navigation.

The equipment shown is the stable-platform unit of a Litton LN-3 navaid system, first to furnish operational aircraft with inertial navigation information to an accuracy within 1.5 nautical miles for each hour of varied flight maneuvers.

The debate: It had been known that an inertial platform could be

built around two two-degree-of-freedom gyros in place of the three one-degree-of-freedom gyros that were the standard concept. And that such a change would offer a number of important advantages including high gyro angular momentum in a compact platform, better servo response characteristics, and freedom from air-bubble problems achieved through the use of low-viscosity damping fluid.

Many inertial engineers felt strongly that the difficulties encountered in trying to manufacture two-degree-of-freedom gyros would more than offset the promised benefits. The difficulty regarded with the most superstitious awe was the problem

of adjusting the center of gravity, center of buoyancy and total weight of the float containing the gyro to achieve neutral buoyancy at a specified temperature and zero torque about all three axes, within extremely narrow tolerances.

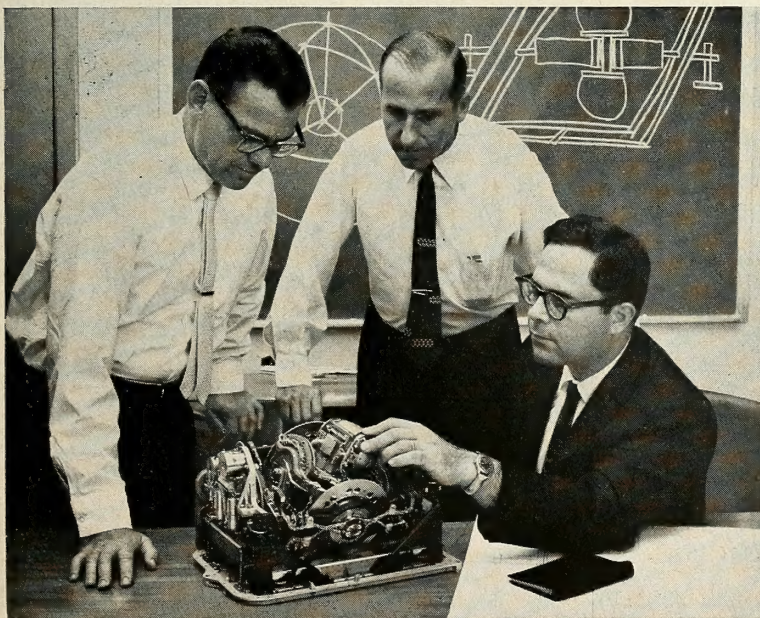
The additional restriction, that the weights placed on the float for balancing shall fall between a minimum and a maximum allowable size, increases the complexity of the actual balance procedure, placing it in the "linear programming" category from a computer standpoint.

The problem was solved by being programmed for solution on a digital computer in order to provide an efficient and reliable balancing process in production. The success of this approach is demonstrated by the world-wide operation of the Litton LN-3 aircraft navigation system, a proven lightweight system of high accuracy that uses two-degree-of-freedom gyros.

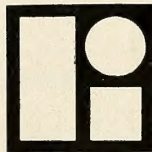
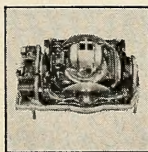
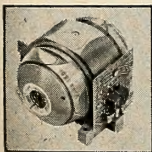
The same approach is being used to expedite the development of even more advanced systems, which will assure Litton's dominant position in the field. They include the Litton Doppler-Inertial System for the P3V anti-submarine patrol aircraft and the P-300 inertial platform of the Air Force Flight Data System for orbital and sub-orbital vehicles.

*It's good to work in the atmosphere engendered when management fully appreciates the value of creative controversy that produces such results. Like-minded design and production engineers with applicable experience couldn't do better than to contact N. M. Pagan, Litton Systems, Inc., Guidance & Control Systems Division, 5500 Canoga Avenue, Woodland Hills, California.*

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## Another Garrett breakthrough in airborne cooling... **DYNA-SOAR**

### *Boeing Dyna-Soar Manned Space Glider*

**Garrett is now developing Dyna-Soar's thermal control system**—again demonstrating its 20-year leadership in the pioneering of airborne cooling methods by its AiResearch Manufacturing Divisions.

An important contribution to the rapid over-all development of the Boeing Dyna-Soar manned space glider, the compact, lightweight system will cool the pilot and his equipment, economically utilizing the

cryogenic hydrogen fuel of the accessory power system.

The development of this hydrogen system exemplifies Garrett's continuing advancements in airborne cooling, including air cycle and Freon refrigeration systems, zero gravity gas and liquid systems, and new developments in space radiators and other systems using exotic liquids and metals...all leading to the development of more advanced thermal control techniques for spacecraft.



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# missiles and rockets

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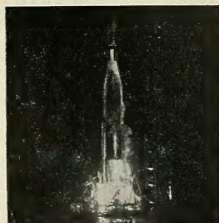
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## THE COVER

*Ranger I launched Aug. 23 failed to go into  
planned orbit when Agena B stage did not  
restart. Backup shot is due next month.  
NASA has ordered 4 more Rangers.*



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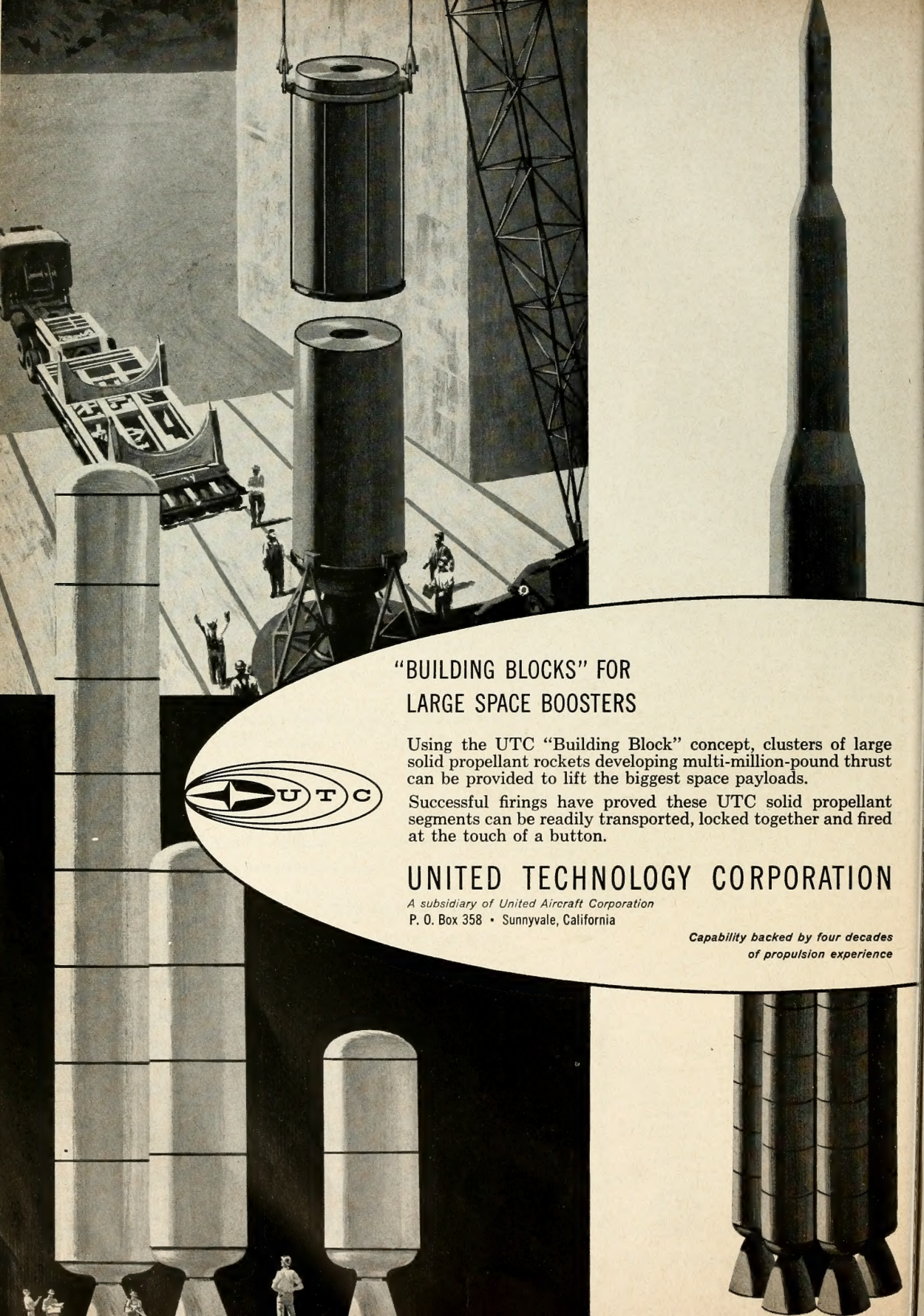
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## "BUILDING BLOCKS" FOR LARGE SPACE BOOSTERS



Using the UTC "Building Block" concept, clusters of large solid propellant rockets developing multi-million-pound thrust can be provided to lift the biggest space payloads.

Successful firings have proved these UTC solid propellant segments can be readily transported, locked together and fired at the touch of a button.

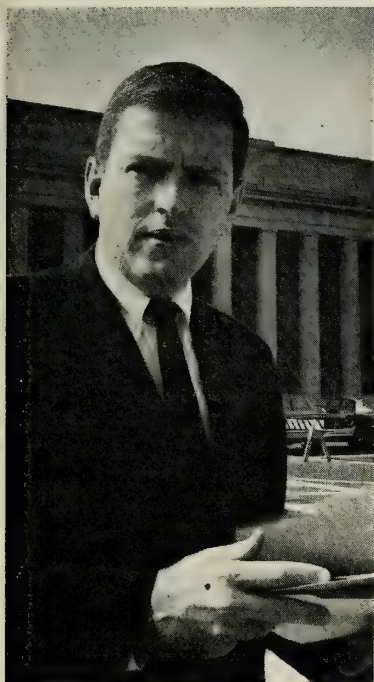
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# memo from the publisher



Senior Editor Baar

ONE OF THE MOST difficult assignment on MISSILES AND ROCKETS involves probing the bureaucratic maze of Washington and pinpointing the significant trends and decisions affecting the missile/space industry as they are being made—the decisions that really count.

For almost three years now, the man who has been performing this important job with consistent lucidity and pungency is James Baar, our editor for military affairs. Many of you readers have noted his unerring eye, and so it is with considerable pleasure that we draw your attention to our masthead, which shows that we have just made Jim a Senior Editor.

This is a new editorial post on M/R and one which Jim's talents have rightly earned.

By a pleasant coincidence, this promotion comes as the latest book written by Jim and Managing Editor Bill Howard — *Combat Missileman* — is being published by Harcourt Brace & World. The book is a definitive account of the key political and strategic decisions we have seen shape the building of our big missile strike force, and it gives the reasons why we stand where we do today.

*Combat Missileman* follows hard on the heels of *Polaris!*, authored by this same M/R team last year, and hailed,

missiles and rockets, September 4, 1961

as one critic put it, as a "can't-put-it-down-until-I'm-finished book."

They have, as sharp-eyed interpreters of what goes on inside this intricate field of ours, also produced articles for mass circulation magazines — all of which, it can be hoped, will add to public understanding of the difficulties we all face in the Space Age.

Interpreting Washington for you in the missile/space industry is, as might be imagined, no easy assignment. A day in the life of our military affairs editor involves a lot of footwork as well as brainwork.

Jim Baar ranges from the Pentagon . . . to Congress . . . to the White House . . . and frequently further afield in the never-ending hunt to find the people who will provide the answers and the facts. They may be admirals, generals, industry reps, the key man on a committee, a company president.

Over the years, Jim's by-line has appeared over many of our lead articles and exclusive stories, from AUTECH to *Nike-Zeus*, from what Congress may do about "non-profits" to the real reasons why we are going into space.

To get these and other significant stories, he has ridden in missile-carrying jet aircraft, walked in the bottom of an *Atlas* silo and even steered a nuclear-powered submarine. Never one to let a story pass by, he took the pictures of the Antigua downrange station (page 16) while vacationing there recently.

"It all may sound rather colorful," says Jim, "but it adds up to one thing: work!"

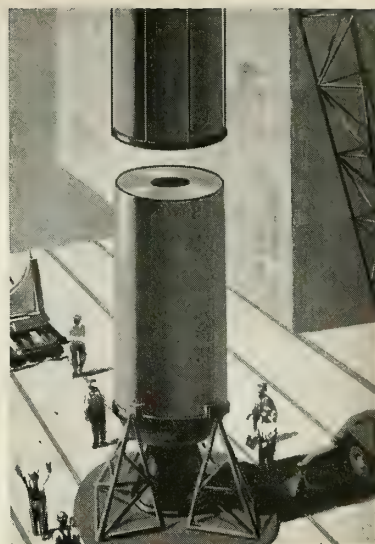
He tops this off by allowing that he usually goes to bed at night reading a transcript of congressional testimony.

Before we lured him away, Jim was applying his energy to covering Capitol Hill and the space field for United Press International. He was with UPI for 10 years, becoming an expert on the ins and outs of the government's decision-making process as well as a highly proficient writer.

Jim lives in Alexandria, Va., with his wife and son and a five-year-old schnauzer named Rupert, who he suspects may be thinking of writing a play.

Perhaps surprising in light of his present occupation, Baar majored in philosophy while in college. But he insists that this is what enables him to interpret the intricate maneuvering and sometimes cloudy thinking that seem to be present in Washington.

*Edward Muhfeld*



## Is there a challenge for you at UTC?

In addition to its big booster development activity, UTC is carrying forward major programs in hybrid rocket engines . . . high energy storable liquid propellant engines . . . and high-performance solid engines for upper stage applications.

Would you qualify for participation in these advanced propulsion programs, working directly with recognized professional leaders at UTC's modern research and development complex in the San Francisco Bay Area? Interviews now are being conducted relative to these positions:

**SR. DESIGN ENGINEER**—Supervision of a group in design of solid rocket motor components. Requires professional degree and a minimum of 5 years rocket design experience.

**ENGINEERING ANALYST**—Systems Design. To formulate mathematical models of systems engineering problems and implement solutions by analytical techniques. Requires degree with solid mathematical foundation and 2 years design or systems experience.

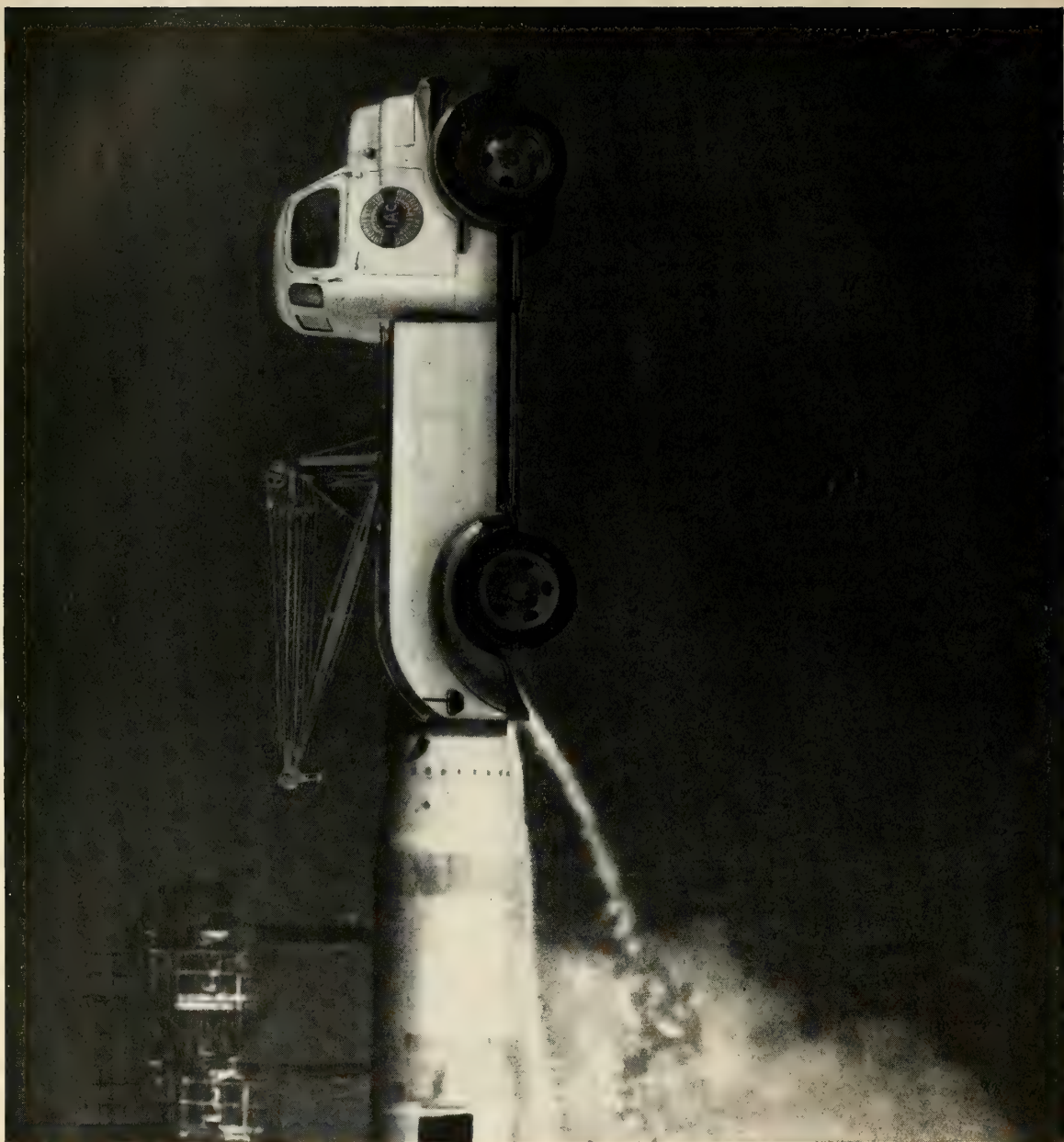
**PROCESS ENGINEER**—For rocket motor processing studies and process method improvements. Requires chemical engineering degree and direct propellant processing experience.

**PROPULSION ENGINEER**—For analytical studies of solid and liquid propulsion systems. Requires degree with extensive mathematics, thermodynamics and fluid mechanics background.

*All qualified applicants considered without regard to race, creed, color or national origin.*

For complete information contact  
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## How do you service a satellite?

The instant a manned satellite goes into orbit, the question of service becomes critical. How do you handle routine or emergency maintenance and repair, for instance? What about getting replacement parts up there, supplying food and other necessities, or removing and replacing personnel?

At Northrop a special task force has been assigned to explore the complex technical problems involved and come up with practical recommendations. They are giving particular attention to such areas as the design of a general shuttle vehicle, close-in rendezvous and docking tech-

niques, requirements for manned maintenance at all levels, and methods for transfer of men, materials and equipment under conditions of weightlessness.

Not all the problems are solved yet, even on paper. But a surprising number of practical answers have been found. That's Northrop's special strength... finding realistic answers to the problems of the space age, and translating them into working hardware.

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A DIVISION OF  
**NORTHROP**



# The Countdown

## WASHINGTON

### Space Policy: A Switch?

Evidence of a possible sharp switch in the Administration's thinking about space has cropped up. Associate NASA Administrator Robert Seamans, Jr., says publicly that if Russia surpasses the United States in space "their space technology in its military aspects will be used to jeopardize our security." Until now, no top Administration official has more than mumbled obliquely that Russia's drive into space is an overt threat to the national security.

### Military Missions in Space

The Air Force has officially pinpointed 12 military missions for spacecraft, satellites and missiles of various types. The missions are: Communications, cargo and logistic support, fueling, early warning, interception-defense, reconnaissance, strategic, target, launching, weather, test and research.

### Apollo May Go Sooner

NASA is in the process of making a possible new revision in its *Apollo* man-to-the-moon program. President Kennedy said earlier this year that the United States would attempt to put a man on the moon within the decade of the 1960's. This was generally interpreted—officially and unofficially—as meaning close to 1970. Now NASA is studying whether it may be possible by 1967 or 1968.

### But More Waiting for Mercury

The chances of orbiting a manned *Mercury* this year grow increasingly sligher. The orbiting of an unmanned *Mercury*, planned for August, now will not be attempted until about Sept. 15 or later. The reason given by NASA: Problems in the *Atlas* booster programs, including the finding of solder filings.

### For Polaris: A Packaged Liquid?

Navy studies looking into the possibilities of developing a follow-on 4000-to-5000-mile-range *Polaris* are weighing a possible switch from solid propellants to packaged liquids. However, there is strong opposition within the Navy to taking large quantities of liquid propellant aboard ships.

### For TAC: An Army-AF MRBM?

The Tactical Air Command is pressing again for development of a 1000-mile medium range ballistic missile. And the build-up of limited war forces could open the way for development of a bi-service Army-AF model. It probably would be based on an upgraded version of the *Martin Pershing*.

## INDUSTRY

### Labor-Management Troubles Hit AEC

AEC officials at the Los Alamos Scientific Laboratory say nuclear rocket and other programs are being plagued by labor and contractor problems. In one instance, guards

walked off their posts at the Nevada test site without notice. The facility was left with no security until more guards could be flown in from other AEC installations. Delays in some programs are said to be the fault of contractors as well as the plumbers, electricians and teamsters unions.

### R&D Intelligence

NASA is studying the possibility of using the *Surveyor* lunar soft-landing spacecraft as a lunar-orbiter for a complete reconnaissance to help the man-in-space program. . . . Specs call for building firefighting equipment right into the *Nova* moon-boosters. . . . Electrical discharge forming is under investigation by NASA-Huntsville as a method of building 300-in. and larger tanks for *Saturn* and *Nova* vehicles. . . . Westinghouse is developing a 400-cycle turbo-generator to power the Navy's *Typhon* antimissile missile.

### The Cape Is It

If a second launch center has to be developed just for *Nova*-type solid boosters, some NASA officials are saying the solid will have to be scrapped. The reason: the nation "can't afford" to spend another \$500 million on top of the new Cape Canaveral expansion (see page 15) for a second launch complex. A committee studying the problem is expected to come up with the answer that both liquid and solid *Novas* can go from the Cape.

### ComSat Cannonade

Expect the Senate Small Business Subcommittee on Monopoly to fire away at FCC handling of the commercial communications satellite ownership question when it begins hearings in mid-October. The hearings will start just after an ad hoc committee of the international telephone companies submit their ownership plan to the FCC.

## INTERNATIONAL

### West Germans Prepare Space Budget

The West German space program now being organized is expected to have an initial budget of from about \$44 million to possibly as much as \$56 million. About half of the money will be spent on a West German national program, the remainder on the West European space program. Two particularly hot projects are development of a communications satellite and mail-delivering rockets.

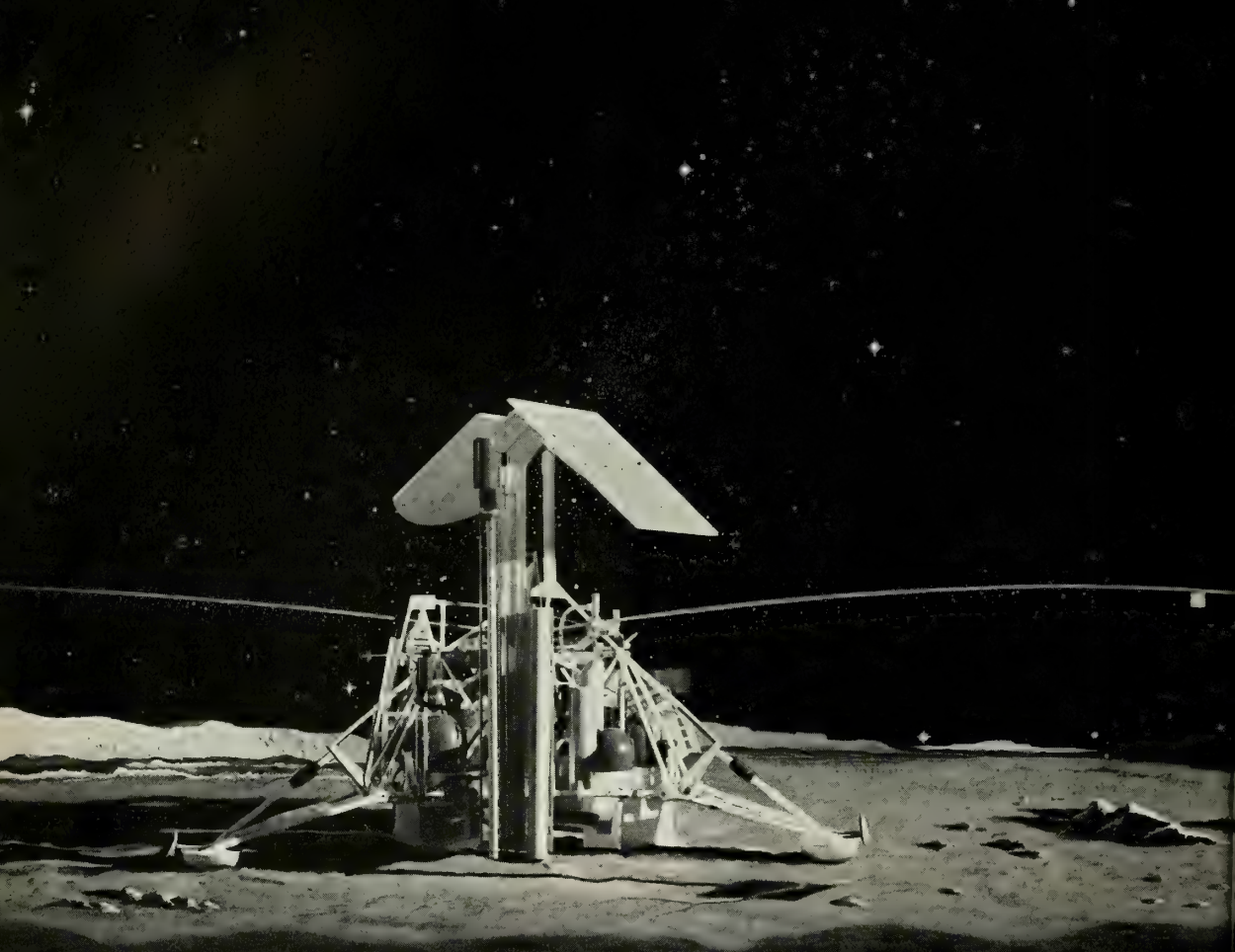
### India Makes and Buys New Missiles

India is working on development of its own air-to-air missiles, presumably for use on its new supersonic fighters. At the same time, the Indians are reported to be interested in buying antitank missiles from Western Europe.

### Overseas Pipeline

SEPR is increasing its capitalization by about 50%. . . . Informed speculation in Europe now says the *Vostok III* expected to be launched late this fall probably will remain in orbit about one week. . . . The Nationalist Chinese are planning an extensive rocket research program on Formosa.





# What will the Surveyor find on the moon?

**Sometime in 1963**, this spacecraft will land on the moon. In it will be over 200 pounds of scientific instruments designed to gather, analyze and transmit information about the moon's surface, subsurface and atmosphere.

The Hughes-designed Surveyor will be built to "soft land." As it approaches the moon, after a 66-hour flight from the earth, retro-rockets will be fired to cushion the impact of landing.

Then, standing on three legs, the 750-pound moon explorer will set to work—as scientists here on earth watch via television. High-quality television pictures of the lunar landscape will be taken and transmitted. Drills will pierce the moon's surface and samples will be brought up into the spacecraft for chemical analyses. Other instruments will measure the geophysical characteristics of the lunar surface, as well as the moon's magnetic and radiation fields.

Hughes will build seven Surveyor vehicles which are scheduled to be launched at Cape Canaveral during the period 1963-66. The work is being performed for the National Aeronautics and Space Administration. Technical direction is by the California Institute of Technology Jet Propulsion Laboratory.

The information which Surveyor gives us will be an important step toward the day when man himself will stand on the moon and look out into the universe.

Creating a new world with electronics

## HUGHES

HUGHES AIRCRAFT COMPANY



# The Missile/Space Week

## Soviets to Resume Nuclear Missile Tests

Russia announced last week that it is resuming nuclear tests—opening the way for extensive development of whole new families of missiles—both tactical and strategic.

It also opens the way for development of space weapons far more powerful than any nuclear weapon now in the arsenals of the East or West.

Many U.S. officials have suspected that Russia has been cheating on the test ban for some time, thereby gaining a significant march on the United States in the development of advanced nuclear weapons.

One informed guess on why the Soviets announced ending the ban at this time is that they wish to test weapons of such power that the tests could no longer be concealed.

## Minuteman Silo Shot Fails

The first attempt to launch an untethered *Minuteman* from a silo Aug. 30 ended in a flaming failure.

The three-stage solid ICBM roared from its narrow silo at the Cape and exploded seconds after clearing the ground.

The launching was the fourth in the Cape test series. The box score: Two successes, one partial, one failure.

## NASA Orders More Rangers

Four *Rangers* have been added to the U.S. lunar exploration program.

Orders for the new spacecraft—with a pricetag of \$20 million each—brings the total number in the *Ranger* program to nine.

NASA is already negotiating a contract with RCA's Astro/Electronics Div. for TV cameras *Ranger* will carry to send high-resolution TV pictures of the lunar surface back to earth.

## Discoverer Monkey Scratched

Long-postponed plans to orbit a monkey in a *Discoverer* capsule now have been scrapped altogether.

The Air Force apparently is planning to join NASA in an animal-orbital program, instead.

Meantime, the Air Force polar-orbited its 29th *Discoverer* satellite on Aug. 30. A recovery attempt was to be made of an instrumented capsule.

Gen. Bernard Schriever, chief of the Air Force Systems Command, said the decision to drop plans to orbit a monkey for four days and recover him came about because of conflict with other Air Force programs.



## Short-lived Explorer

*EXPLORER XIII* micrometeoroid satellite was launched aboard a Scout vehicle Aug. 25 from Wallops Island, Va. It re-entered the atmosphere on Aug. 29.

## Missile Frigates Ordered

The Navy last week awarded contracts for three guided missile frigates to be built under its ship construction program for the current fiscal year.

The Puget Sound Naval Shipyard will build two frigates, to be armed with missiles, antisubmarine rockets, torpedoes and conventional guns. The third ship will be built by the San Francisco Naval Shipyard.

## Titov Has No Ill Effects

A Soviet space scientist says prolonged weightlessness had no effect on Gherman Titov's work capacity, bodily functions or nervous system during 25 hours in orbit.

**Electronics is our business.** Imaginative pioneering in advanced electronics by more than 5,000 Hughes engineers and scientists is speeding man's progress in a host of new ways—with revolutionary 3-dimensional radar systems, with ion engines to take man on long space journeys, with computers that can do years of work in hours. Such creative efforts have helped build Hughes into one of the world's most important producers of electronic systems and products.



# Centaur Slippage Fouls Plans

**Extra three-to-four month setback will delay first Atlas-Centaur firing until next year; main trouble is inexperience.**

By Hal Taylor

FIRST FLIGHT of NASA's hydrogen-oxygen *Centaur* booster is slipping into 1962. The new delay is playing havoc with planetary, lunar and satellite flight schedules.

MISSILES AND ROCKETS learned this week that NASA now is anticipating a three-to-four-month additional delay in the first test of *Atlas-Centaur*, forcing a re-evaluation and rejuggling of schedules.

Originally, *Centaur* was to have been launched in June. This subsequently was moved back to the last of this year. The new delay will move the shot into 1962.

The program most affected is the *Mariner* fly-by of Venus, which was set for mid-1962, the next optimum period for a shot at the planet. Since three test flights of *Centaur* are needed prior to the fly-by attempt, it appears almost certain that the booster vehicle will not be ready until next fall—about three months late.

Venus will not be in position for another fly-by attempt until 1964. But NASA is making provisions for a substitute *Mariner* launcher, probably an *Atlas-Agena B*.

The slippage may also delay the scheduled launch late next year of the first Army *Advent* active repeater communications satellite and affect the timetable for the first *Surveyor* lunar soft-landings in 1963.

• **Production jam-up**—Development delays, moreover, are squeezing the *Centaur* production schedule. Beginning in 1963, 10 *Centaur*s are scheduled for use as the second stage of *Saturn C-1*. This demand could create a shortage of *Centaur*s for other space programs. *Saturn-Centaur*s have nine RL-10 10,000-lb-thrust engines, and *Atlas-Centaur*s have two 15,000-lb.-thrust engines.

Col. Daniel D. McKee, technical assistant to the director of NASA's Office of Launch Vehicle Programs, contends that there is still a 50-50 chance that the first *Centaur* will be launched by the end of the year.

NASA's Space Flight Office has already been told, however, to find a substitute for *Centaur* in the *Mariner* program. The *Mariner* shots were to use No's. 4 and 5 of the *Centaur* vehicles and were scheduled for launch in August, 1962.

They are expected to pick the *Atlas-Agena B*, which can only boost 750 lbs. to escape velocity, compared to *Centaur* payloads of 1500 lbs. As a result, it is certain that the *Mariner* payloads will have to be scaled down considerably.

Numbers 6, 7, and 8 in the *Centaur* series were slated to boost joint NASA-DOD payloads. The first two in late 1962 and the third in early 1963. The DOD payloads will be in conjunction with *Advent* and NASA's will be a piggyback geophysical experiment.

Twenty *Centaur*s have been ordered, with numbers 9 through 20 scheduled for *Surveyor* and the *Saturn* programs.

NASA is pumping \$56 million into *Centaur* in FY '62. Under the original *Centaur* schedule, the first three launches of the vehicle were to be completed by late 1961.

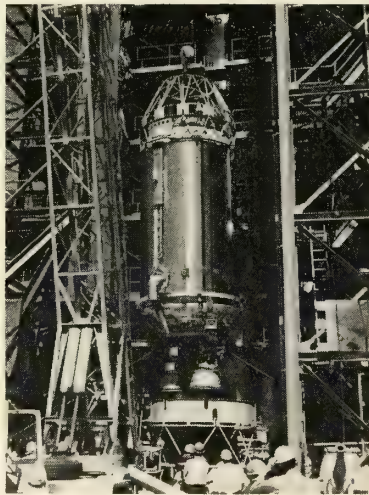
• **Sources of trouble**—Ignition problems with the simultaneous start of its two RL-10 LOX-liquid hydrogen engines has caused most of the present slippage and resulted in three explosions at the Pratt & Whitney engine development center at West Palm Beach, Fla.

The two engines must start within milliseconds of each other. Otherwise, hydrogen and oxygen soon build up to an explosive mixture in the closed chamber used for the engine tests.

New problems have developed which are not of major significance, but their solution has forced further

delay into the program to the point that further slippage of the launch date into 1962 is considered likely.

The overall problem of the *Centaur* program, according to NASA officials, is that it is a pioneering development which is pushing the state of technology every step of the way. Previous experience in the use of supercold ( $-428^{\circ}\text{F}$ ) liquid hydrogen as fuel was limited to research programs. And, to complicate matters, LOX and liquid hydrogen are not hypergolic. An ignition system is required. ✱



*CENTAUR* to be used as second stage with *Atlas* is raised in gantry at Canaveral.



NERVA flight in '65? . . .

# Nuclear Stage Key to Moon Trips

A NUCLEAR third stage would give *Nova* and *Saturn* boosters the capability of direct flights to the moon—perhaps by NASA's 1967 target date for manned moon landings.

A crucial series of tests on the Kiwi-B reactor in October and early next spring holds the key. If these succeed, NASA officials believe, the nuclear rocket engine, *NERVA*, can be test-flown in 1965. This would probably make it possible to mate a nuclear third stage with either a four-F-1-engine *Nova* or a two-F-1-engine *Saturn* booster by 1967.

Harold B. Finger, director of the joint AEC-NASA nuclear rocket program, told Congress that either vehicle would be capable of boosting NASA's minimum requirement for a 12,300-lb. return payload from the moon. Without a nuclear stage, these vehicles would be able to make a manned lunar landing only through the use of the "rendezvous" space concept.

Mated to a four-F-1-engine *Nova* booster, Finger said, a nuclear third stage would be able to send an *Apollo* spacecraft on a direct flight to the moon with capability of returning a payload of 17,000 lbs.—well over NASA's minimum standard.

Performance with a two-F-1-engine *Saturn C-3* booster would be marginal, but still equal to a direct moon flight.

A nuclear-engine third stage with a thrust of 250,000 to 350,000 lbs. on the *C-3* would have a return capability of only 12,500 lbs.

Both estimates are based on the use of a hydrogen-oxygen return rocket for the *Apollo* spacecraft.

• **Boost for NERVA**—If the upcoming tests are successful, NASA Administrator James E. Webb told the Joint Committee on Atomic Energy, a big boost in *NERVA* funding will be requested in the Fiscal 1963 budget. In Fiscal 1962, combined funding of both AEC and NASA for the project is only \$89 million.

He also said that a contractor for the project will be chosen early in 1962. Best bet is that the contract will go to the joint Aerojet-Westinghouse development team. Only an unsatisfactory performance in the team's current six-month development contract would force NASA to look for another contractor.

The principal purpose of the upcoming tests on the Kiwi-B reactor is to determine what materials will be required for the reactor core structure.

The first test in October will be run with gaseous hydrogen as the reactor coolant and propellant. The test next spring will mark the first use of liquid hydrogen.

As an example of the seriousness

with which NASA views the potential of the nuclear rocket for manned lunar missions, space agency officials said that all of the *Saturn* and *Nova* boosters will be designed so that their upper stages can be modified to use atomic power.

The growth potential of such vehicles was also stressed. This lies principally in the four-F-1-engine *Nova 4*, developing a thrust of six million lbs.

• **Pressing for SNAP**—In another nuclear space application development, officials of Atomics International told the committee that the big problem in the development of *SNAP 10-A*, the 500-watt thermoelectric auxiliary power unit, in Fiscal 1962 is to obtain a thermoelectric power conversion subsystem.

Because of the critical schedule, two parallel concepts are being pursued. One concept utilizes the vacuum of space as the electrical insulator at the cold junction of the thermoelectric elements. This minimizes thermal and electrical losses and direct-couples the thermoelectric converter to the space radiator.

The alternative concept uses a very compact design wherein the thermoelectric elements are made up in annular rings that are stacked one upon another with the reactor coolant passing down the center and a secondary coolant on the outside to carry the heat to the space radiator. ❖



300'

396"

LUNAR LANDING AND  
EARTH RETURN STAGES

STAGE III  
NUCLEAR ENGINE  
LH<sub>2</sub>

STAGE II  
4 J-2 ENGINES  
LOX-LH<sub>2</sub>  
THRUST 800,000 POUNDS

STAGE I  
4 F-1 ENGINES  
LOX-RP  
THRUST 6,000,000 POUNDS



200'

360"

SATURN S-IV STAGE  
6 A-3 ENGINES  
LOX LH<sub>2</sub>  
THRUST 90,000 POUNDS

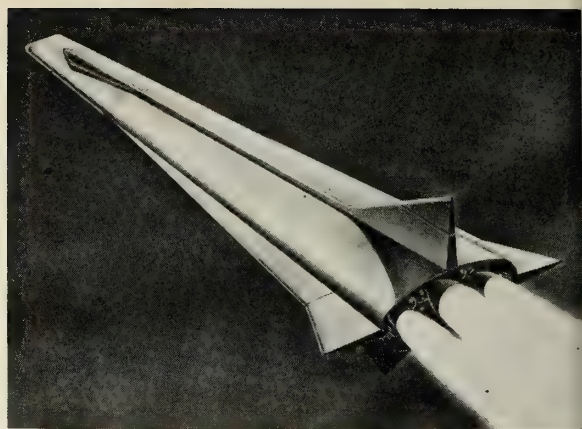
STAGE II  
4 J-2 ENGINES  
LOX-LH<sub>2</sub>  
THRUST 800,000 POUNDS

STAGE I  
2 F-1 ENGINES  
LOX-RP  
THRUST 3,000,000 POUNDS

NUCLEAR NOVA 4—Thrust for manned deep-space trips.

NUCLEAR SATURN C-3—Power for direct moon flight.





"ASTROPLANE" would use flex wings for take-off, landing.

LENGTH of craft would protect crew from nuclear reactor.

Using liquid nitrogen . . .

## Martin Reveals Nuclear ASP Concept

**Elongated craft would have size of B-70 and ability to use present runways; surface would radiate heat energy**

DENVER—Design approach to *Aero-space Plane (ASP)* at The Martin Co. calls for eventual use of a nuclear-liquid nitrogen engine, MISSILE AND ROCKETS has learned.

Although admittedly not as efficient as Marquardt Corp.'s LACE (liquid air cycle engine), which employs liquid oxygen and liquid hydrogen, the nuclear monopropellant system is said to offer promise of a smaller vehicle.

The resultant spacecraft would be approximately the size of a B-70, with a full capability of using present-day runways, according to Martin designers.

Dr. Carl Kober, director of advanced technology at Martin-Denver, describes the design, labeled *Astroplane*

by the company, as a long-range goal in the firm's advanced programs.

Design sketches (see photos) reveal a lengthy craft, due both to need for extensive tanks for storage of liquid nitrogen scooped from the atmosphere and to use of distance as crew protection from the nuclear reactor. The lifting body concept is employed for re-entry, with extendable flex wings for landing and take-off.

Another design factor is use of the vehicle surface as a radiator for dissipating heat energy from the reactor and from the decelerated scooped gases. Since this must be in proportion to the scooping rate, which is determined by altitude and inlet radius, the vehicle will be long with a small cross-sectional area.

It would be capable of scooping up its fuel at altitudes as low as 320,000 ft.

Air Force ASP specifications call for a spacecraft capable of taking off from B-52 runways, accelerating to or-

bital speed and returning to the take-off field. Some eight study contracts now are said to be out on the ASP concept. Cost of bringing such a craft to operational status by 1970 has been estimated at from \$3-5 billion (M/R, May 29, p. 43).

• **Nitrogen with MHD?**—Some indication of the type of propulsion system which might be applicable is contained in the August issue of *Astrotechnics*, in an article by Morton Camac and Felix Berner of the Avco-Everett Research Laboratory.

They suggest that nitrogen can be used as propellant in electrical-propulsion systems, such as magnetohydrodynamic (MHD) accelerators of plasma. The authors note that even to balance the drag in an air-scooping vehicle, thrust must be supplied to maintain a constant satellite orbit.

"A portion of the scooped gases, preferably nitrogen, would be used for the propulsive fluid to balance this total resultant drag," they report. "To do this, the exhaust velocity would have to be larger than the satellite velocity—greater than 26,000 fps. Since only an electrical-propulsion system can accelerate gases to this velocity, a large electric powerplant is required. Moreover, it can be shown that an MHD accelerator is the only practical means of achieving the necessary specific impulse, which must be in the range of 1000 to 1800 sec. The MHD system would accelerate nitrogen by electromagnetic forces through a jet nozzle."

Energy source would be nuclear. ❖

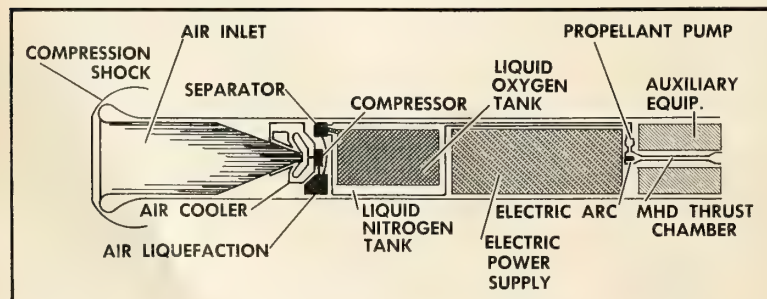


DIAGRAM OF A LIQUID NITROGEN ENGINE based on drawings in *Astronautics*.



# Cape Expansion to Cost \$500 Million

NASA EXPECTS to spend well over \$500 million on the just-ordered expansion of Cape Canaveral as a launch site for moon expeditions.

Biggest construction items at the beefed-up facility will be six new launch pads—three for *Saturn C-3* and three for the *Nova* booster, a control and assembly building for the *Saturn C-3*, a blockhouse-type building for *Nova*, a complete cryogenic facility for manufacturing and storing liquid propellants, a building to assemble and check out the *Apollo* spacecraft, special facilities for dynamic testing, and a bio-medical building to house moon expedition crews. In addition, there will be a whole host of minor support buildings.

Construction and preparation of sites will begin this spring with perhaps the heaviest expenditure of funds to come in Fiscal 1963. All of the construction will be completed and ready for use by 1966.

Some \$60 million of the half-billion-dollar layout will go to purchase of land.

- **New prosperity**—The expansion of Cape Canaveral will prove a real boon to the surrounding Florida area. More than 5000 NASA and industry employees will be added to the Cape's payroll, which now totals 1200.

Physically, the Cape launch site will be increased by five times its present size—to a total area of 100,000 acres, 25 miles long and 10 miles wide at its broadest point.

NASA officials said that final specifications for new buildings and the launch pads may be delayed as much as several months because of pending decisions concerning the size of boosters and other aspects of the *Apollo* program. They did, however, release the following details:

- **Launch Pads**—At least six will be built, but there is room for more. The pads will be built along a 20-mile strip north of the present boundary of the Cape.

The *Saturn C-3* pads — of which there will be three and perhaps more if the space agency decides to use the "space rendezvous" concept for moon missions—will have practically no gantry. Instead, each pad probably will have a simple umbilical mast which will be used in part to get astronauts in and out of the *Apollo* spacecraft. The lack

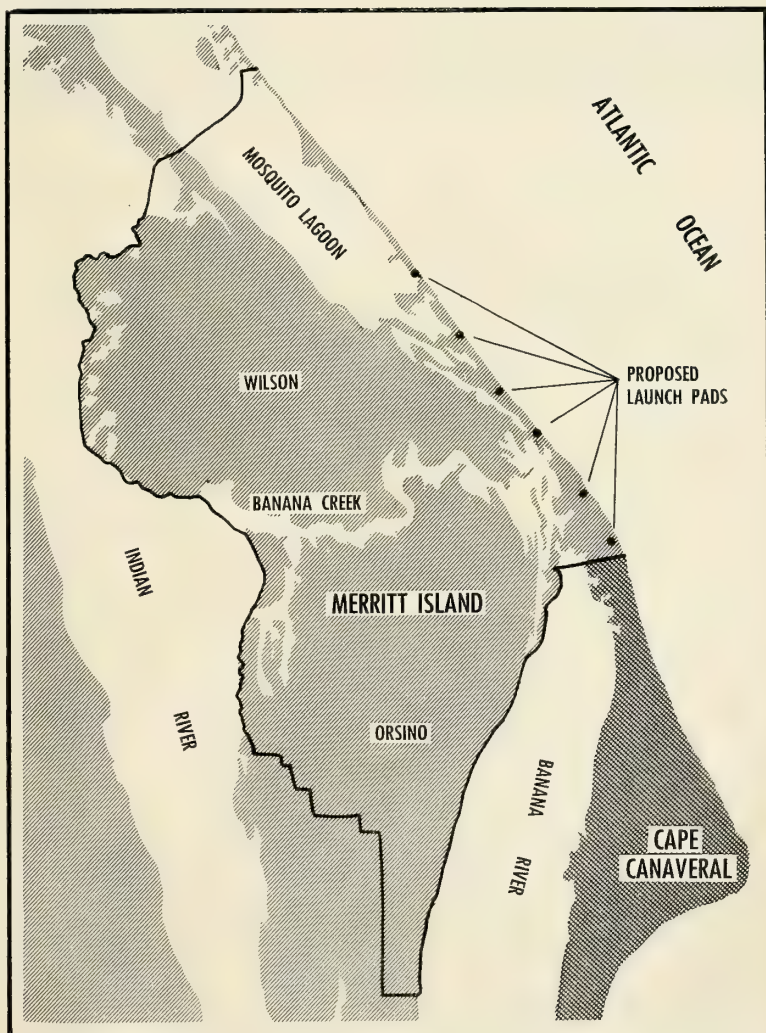
of complex facilities stems from the fact that the *C-3* will not be assembled on the pad but instead will be put together in a building about a mile away.

The *Nova* pads will be monstrous. Gentries will be 500 feet tall and have built-in capacity of withstanding 60-knot winds. Because of the size of the gantry, the space agency still has no definite way of getting it out of the way before the booster is launched. Proposals being studied include hinging it so that it can be bent backward, flying the

bird out through the gantry (similar to the *Minuteman* "silo" concept), and splitting the gantry into two halves, so that each side can be moved back slightly.

- **Vertical Assembly Slant Control Building**—This will be used to control the assembly and launching of the *Saturn C-3* booster. As a result, it will have the tallest room in the world—with a ceiling of 400 ft.—where the *Saturn* vehicle will be assembled in a

(Continued on page 44)



HEAVY DARK LINES indicate boundary of expanded Canaveral launch facilities. *Saturn C-3* and *Nova* pads will be located along 20-mile strip of coast.

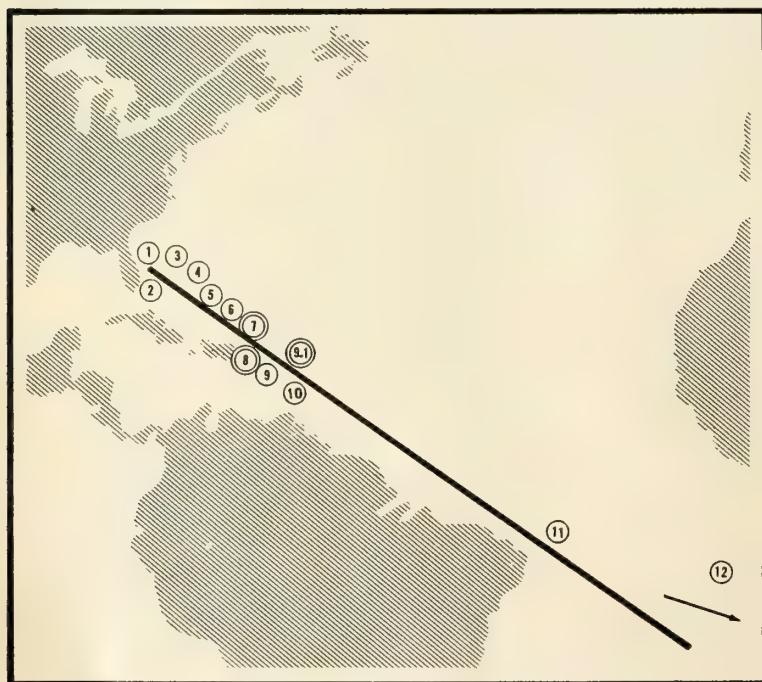




To be ready in '63 . . .

## AMR Cable Extension Will Bypass the

*New role as terminus of northern part of range will add to importance of Antigua, also monitor of Polaris impacts*



**DOWNRANGE STATIONS** are now tied by underwater cable from Cape Canaveral (1) to Mayaguez, P.R. (9) via Dominican Republic (8). New cable extension will run from Grand Turk (7) through Mayaguez to Antigua (9.1), bypassing Dominica. Other stations: (2) Jupiter; (3) Grand Bahama; (4) Eleuthera; (5) San Salvador; (6) Mayaguana; (10) St. Lucia; (11) Fernando de Noronha. Ascension (12) and Pretoria (13) are not on map.

THE CURRENT EXTENSION of the underwater cable that links Cape Canaveral with most of the upper half of the Atlantic Missile Range will enable the Air Force to avoid possible future political problems in the troubled Dominican Republic.

The important cable, which carries radar data, real-time telemetry and administrative traffic, now extends from the Cape of Mayaguez in Puerto Rico via a relay station near the Dominican Republic town of Sabana de la Mar.

The cable extension will run from Grand Turk Island directly to Mayaguez, skirting the Dominican Republic, and continue on to the Island of Antigua, British West Indies.

The Air Force awarded a \$5-million contract last June to the U.S. Underseas Cable Corp. to lay the cable and underwater relay stations. Station equipment is being procured from the West German firm of Felton & Guillaume. The work is expected to be completed in about two years.

Completion of the extension will enable the Air Force to close its station near Sabana de la Mar, which some officials felt was vulnerable during the political troubles in Dominica this summer and could be again.

• **Double duty**—Extension of the cable to Antigua considerably enhances the importance of the already important island as a downrange station. Antigua not only is the key link at the end of the upper range but also has been the monitoring point for the impact of

missiles and rockets, September 4, 1961





**LEFT:** *Antigua Auxiliary AFB, or Down-range Tracking Station 9.1, is spread over some 280 acres of Island of Antigua, largest of Leeward Islands in the Caribbean.*

**RIGHT:** *Main dish of Air Force tracking station on Antigua. The station is "up" for a launching on an average of three to four times a week; the rest of the time is spent in maintenance.*

## Dominican Republic

*Polaris* missiles launched from the Cape.

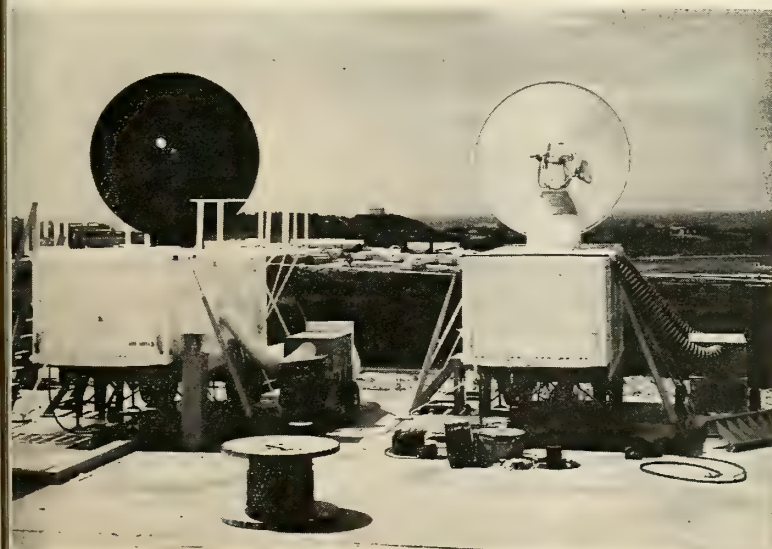
The island tracking station—1250 miles from the Cape—is manned by one Air Force officer and about 130 civilians. About 60 of the civilians are employed by Pan American; the remaining 70 by RCA.

Civilians receive a 30% bonus for working on the island. Their average tour of duty ranges from about 6 months to three years or longer. Civilians without dependents on the island

live and eat at the station. Room and board is provided as part of their contract.

The station—situated on a long-abandoned U.S. Army base—was set up in 1957. Permanent construction was completed in 1959.

A U.S. Naval Oceanographic Station on the island maintains the MILS bull's-eye nearby in the Caribbean for *Polaris* tests. The station is manned by about 100 officers and men. ❖



**MOBILE ANTENNAS** are emplaced on top of hill overlooking base and Naval Oceanographic Station that operates the "bull's-eye" for *Polaris* tests.

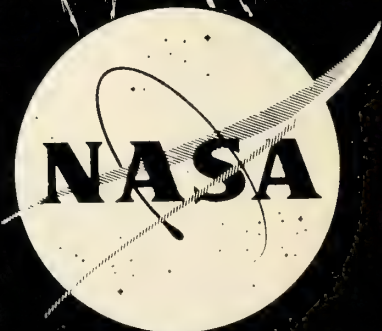
missiles and rockets, September 4, 1961







nasa's apollo program | \$20 billion for industry



MISSILES AND ROCKETS/SPECIAL NASA ISSUE/NOVEMBER 27, 1961  
ADVERTISING CLOSING DATE/NOVEMBER 6, 1961/AN IMPORTANT ISSUE COVERING NASA'S/PRO-  
GRAMS AND PROJECTS/FACILITIES/PERSONNEL/BUDGET/CONTRACTING PROCEDURES



# Technical Countdown

## ASTRONAUTICS

### Earth-Venus Distance Further Refined

Using advanced radar astronomy techniques, RCA scientists have reportedly succeeded in determining the distance between earth and Venus to an accuracy of 200 miles in the 30-million-mile span. An 84-ft. radar tracking antenna—designed and developed for RCA by Goodyear—bounced beams of radio energy off Venus and determined the pattern of the returning echoes with the assistance of a high-speed computer which made six billion calculations of the incoming data.

### Limitations on Lunar Launch

A report recently released by NASA's Lewis Research Center outlines some of the limitations on direct launches from the earth's surface to the moon. In describing the mission, the report notes that the booster may travel as much as 30° to 40° down range, causing a shift in the burnout latitude which may seriously increase the energy required for the flight. To compensate for this and other anomalies, reasonably low-energy trips may be made only during the first half of the lunar nodical month—and even during this period many days will be unsuitable, since the flight paths may pass over populated areas.

### Bowling Ball Scores Space Strike

An ordinary bowling ball helped Lockheed engineers solve the problem of returning a *Discoverer* data capsule from space. Used as an air-cushioned bearing, the bowling ball enabled the engineers to test a new spin stabilization system for the *Discoverer XIII* capsule, which later was recovered from orbit.

## SPACE MEDICINE

### Space Hypnosis

A survey is being conducted to seek out specific ways in which a cosmonaut may use hypnosis to adjust to space travel. Dr. H. McCord, University of Colorado, is contacting leading psychologists and physicians all over the world.

### High Flying Quails

Quail eggs and fruit flies hitched a 40-mile ride on a Navy weather rocket launched from Point Mugu in a three-way experiment designed to investigate the weather study effect of radiation on the specimens, and check out the specimen capsule. The eggs will be hatched and the flies bred to determine the effects, if any.

### Solar Food Warmers

Astronauts flying through space may have hot meals warmed by the sun. A solar stove developed by REF Manufacturing Corp. for the Air Force consists of a magnesium plate for collecting solar energy and an integral half-cavity to hold three food containers. A warmer door mounted on slotted hinges aligns the magnesium plates and incorporates three face-mounted thermometers to measure the individual food cavity temperatures.

### Grass in Space Ships

Martin Co. Biochemist E. W. Chappelle has found that missiles and rockets, September 4, 1961

green plants will protect future astronauts from the deadly effects of carbon monoxide produced by the ship's electrical system, fuel combustion and the pilots themselves. Chappelle is investigating the mechanisms involved which convert the monoxide to the dioxide. His findings so far show the reaction to be universal, requiring only oxygen and independent of light.

## ELECTRONICS

### Electrical Balance for Gyros

A device to balance gyros by inducing electrically the right amount of compensating torque has been patented by E. J. Mullarkey, president of Avcon Corp. The device—called a Mass Shift Compensator—functions as an electrolytic cell with two equal masses of metal aligned at opposite ends of a small glass cylinder filled with a suitable electrolyte. Depending on the polarity of the d-c current, molecules of metal deposit themselves on one end or the other of the tube. As the relative mass of the electrodes changes, a compensating torque is induced and the gyro brought back into balance.

### Apollo Guidance 'Outs'?

Selection by NASA of the Massachusetts Institute of Technology to develop the guidance system for *Apollo* is a bitter blow to many leading guidance manufacturers. Dr. C. Stark Draper's almost contemptuous opinion of two-degree-of-freedom-gyro systems, say industry observers, will serve as an insurmountable barrier for those companies who have taken that approach in their missile guidance development. Companies who may feel they are already out of the running include: Autonetics, Arma, Bell Aerospace, and Litton. M.I.T. has been directly associated with guidance system design and development for *Polaris A-1*, *A-2*, *A-3*, *Thor* and *Titan II*. All employ single-degree-of-freedom gyros.

## ADVANCED MATERIALS

### Gold-plated Teflon

Continuous thin films of gold covering the inside of the bladders in positive fuel-expulsion systems will increase the fuel-holding efficiency of the units. Chemically deposited gold reduces the permeability of teflon to some high-energy fuels by as much as 10 to 1000 times. Quantum Inc., a research firm, and Joclin Manufacturing Co., producers of fuel bladders, cooperated in the discovery.

### Two New Space Chambers

Chicago Bridge & Iron Co. engineers are working with an 8 by 18-ft. vacuum chamber capable of reaching pressures down to  $5 \times 10^{-7}$  mm Hg. Lower ultimate pressures will be attainable with the addition of a cryogenic trapping system. The unit is currently being used in the Grumman *Orbiting Astronomical Observatory (OAO)* project. . . . GE's Missile and Space Vehicle Dept. has reported that a low pressure of  $3 \times 10^{-7}$  mm of mercury was achieved with diffusion pumps alone during checkout of their space simulator at the Valley Forge Space Technology Center. With the installation of cryogenic panels this fall, pressure levels of  $10^{-9}$  mm of mercury should be possible.





## AEROJET FIRES WORLD'S LARGEST SOLID ROCKET

This segmented solid rocket booster developed far more energy than ever before achieved in solid rocket technology, surpassing the previous largest booster fired, also an Aerojet-General motor. Built and tested by Aerojet-General for the Air Force, this flight-weight segmented motor, com-

bined with more of the same units, could launch a three-man orbital flight. The success of this firing, at a thrust level of approximately a half million pounds, confirms Aerojet's technical ability to scale up and produce *reliable, low-cost* solid propellant boosters for lifting large payloads into space.



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# Nimbus Will Carry PCM Telemetry

First satellite system to use PCM will benefit most from its low power demands; Radiation, Inc., wins award

by James Trainor

**NIMBUS**—NASA's follow-on program to the highly successful *Tiros* meteorological satellite—will be the first satellite system to use Pulse Code Modulation (PCM) telemetry.

Details of the spacecraft PCM system were revealed recently in an announcement of a contract award to Radiation, Inc., for the ground and space vehicle telemetry systems.

An advanced weather satellite, the first *Nimbus* vehicle is expected to be launched into a 600-mile, polar orbit about the middle of next year. Although designed as a transitional system until the 24-hour *Aeros* satellite system is developed, *Nimbus* will represent a marked improvement over *Tiros* by providing complete global coverage due to its earth stabilization and polar orbit.

• **PCM system**—Each *Nimbus* spacecraft will carry two electrically independent PCM systems weighing less than 30 lbs. and consuming only 1.4 watts of power. Both systems will be

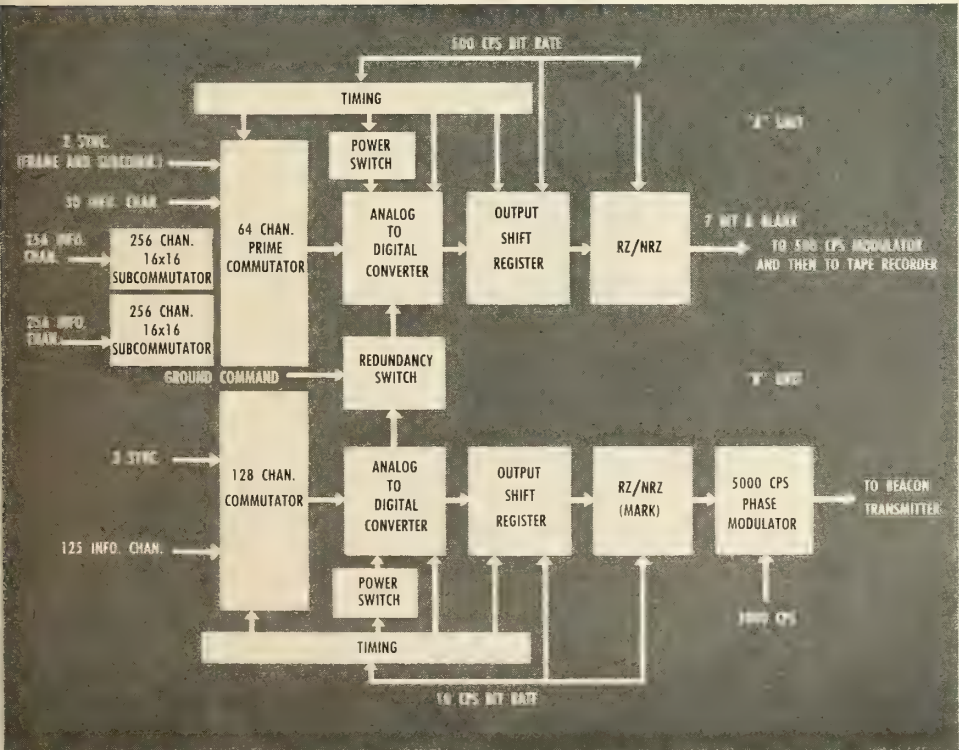
located in a pie-shaped segment of the satellite's circular body. The first system (Unit A) continuously stores data on tape for command readout and is capable of handling some 540 channels, while the second system (Unit B) delivers 128 channels by direct transmission.

The ground stations receive and process the data transmitted from the satellite and, by visual displays, allow an immediate review of the cloud picture information gathered over much of the globe. In addition, the PCM ground system can present visual displays of selected data on an oscillograph for an immediate look at information as it is actually being received.

• **Low-power advantages**—Probably the greatest advantage of the *Nimbus* PCM system is the low power requirement for the satellite-borne packages. Simplifying the circuitry and reducing the number of transistor devices for each gate has reduced the power drain by the multiplexer substantially.

The total power requirement — 1.4 watts for both systems—enables a reduction in the number of solar cells and, consequently, the total vehicle weight. The resultant power savings are estimated at 30-1 over present systems.

• **PCM system details**—The telemetering subsystem accepts information from all the satellite "housekeeping" subsystems as well as from the low-rate data sources and scientific experiments aboard the vehicle. Information of the yes-no type or in analog signal form is stored by the A unit for command readout, or directly transmitted by the B unit upon interro-



NIMBUS, scheduled to be launched in late 1962, will be first U.S. spacecraft to use PCM telemetry.



gation. During the operation of the B unit, the A unit is turned off.

The A unit—consisting of a seven-bit analog-to-digital converter, a 540-channel multiplexer, subcommutator, gates and registers—employs less than one watt of continuous power for monitoring the data channels and for continuously checking the performance of such things as the attitude control systems, gyroscopes and radiometers. These channels are time-multiplexed and serially recorded upon tape at a bit rate of 500 cps for playback at 15,000 cps—a 30-1 ratio of time compression.

The unit's coder, similar to that used in the B unit for redundancy, accepts unsymmetric inputs from zero to minus 6.4 volts with a channel input impedance of 100,000 ohms.

- **B Unit operation**—Operating only upon ground command, the second PCM unit uses less than four-tenths of a watt operating power to scan 128 channels of less critical data at slow speed for a 1.75-minute reporting period. This enables ground stations to obtain several scanning sequences during the 18 minutes in which the satellite is within range.

The B unit consists of an analog-to-digital converter similar to that of the A unit, a multiplexer, gates and a phase shift modulator. Employing a bit rate of 10 bits/second with a maximum of 128 words, the direct unit includes

synchronization with three words in the form of all "ones" followed by all "zeros" followed by all ones."

Both units are controlled by separate clocks located in another subsystem. These clocks furnish 500 cps to the A unit and 10 cps to the B unit in the form of 1 volt peak-to-peak square waves.

- **High reliability guaranteed**—In general, the system components operate at power levels below the maximums prescribed by the specifications and, therefore, contribute to the reduction of potentially destructive internal heat. Other factors which increase the system reliability include: system and circuit redundancy, careful parts selection, exhaustive testing of circuits and components, and special environmental packaging.

To further guarantee the system's reliability, the coder modules in both the A and B units can function in place of each other automatically or upon ground command. Parallel and in some cases quadruple circuitry has been designed into the system to increase reliability in vital areas.

- **Rugged testing planned**—To realize the system's required design life of a minimum of six months in orbit, a comprehensive testing program has been planned for the satellite-borne telemetry packages. The rugged environmental tests of the PCM systems will be conducted for long durations in a vacuum

of  $10^{-6}$  mm of mercury. A temperature-altitude cycling test between  $0^{\circ}$ - $55^{\circ}$ C is to be conducted for a period of 13 days operating time. Sinusoidal and random wave vibration tests will also be run for accelerations of 10 and 20 gs, respectively. The effects of a 30-g linear acceleration that the system might experience on launch will also be studied.

- **Future developments**—Although the PCM system for *Nimbus* is the first such satellite telemetry system, Radiation, Inc., has indicated that a second PCM system to be used with a communications satellite will soon be announced. Under the *Nimbus* pact, Radiation will design, develop and fabricate seven complete systems—two prototypes and five flight models.

NASA's Goddard Space Flight Center at Greenbelt, Md., will manage the contract. In addition to Radiation, the *Nimbus* contractors include: General Electric's Missile and Space Vehicle Dept. (integration, test and stabilization), RCA Astro-Electronics (cameras and solar power systems) and IT&T Laboratories and Santa Barbara Research Center (infrared equipment). \*\*

## Dyna-Soar type Vehicles Urged for Navy A-ICBM Use

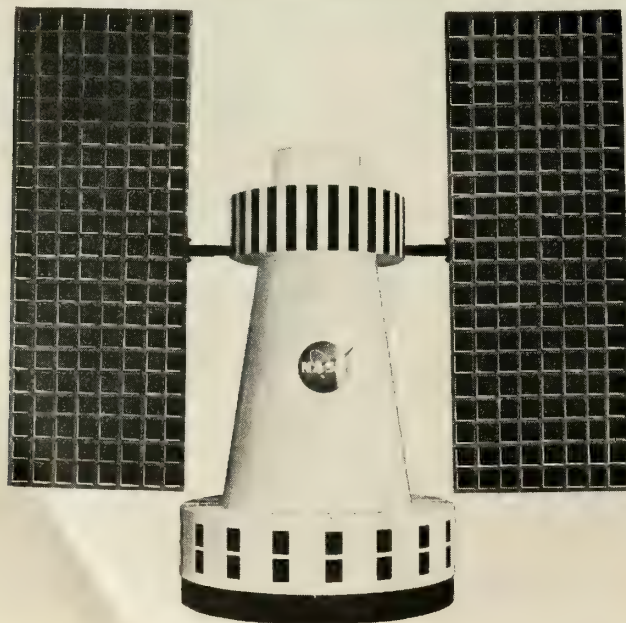
THE NAVY is considering use of *Dyna-Soar*-type vehicles launched from aircraft carriers to protect its surface vessels against attack by ICBM's.

The manned boost-glide approach has been proposed as a part of fleet air defense by McDonnell Aircraft, which is conducting an in-house study of the concept. It was described at a classified session of the IAS/Naval Aviation meeting in Los Angeles by John Aldridge, McDonnell vice president/advanced projects.

The advanced concept is entirely feasible, Aldridge said, and the powerplant is "almost within the state of the art," or within the 1970 time period. He noted that the boost-glide craft would have quick reaction time and could loiter for extended lengths of time several hundred miles away from the heart of a task force.

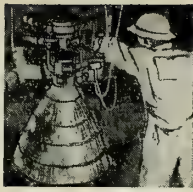
The Navy's only present defense against ICBM's is its "three T's"—*Terrier*, *Tartar* and *Talos*. All of these have limited tracking ability. The *Typhon* system now under development will have improved tracking.

An anti-satellite system for the Navy is being studied by Chance Vought, company Vice President W. P. Thayer disclosed. He said the proposal calls for a sea-launched system which could be used for surveillance of orbiting satellites or a defense against other threats from space, more economically and effectively than airborne platforms.



SCHEMATIC SHOWS PCM telemetry packages, consisting of two main units, for *Nimbus*. These units greatly enhance weather data gathering and transmission.



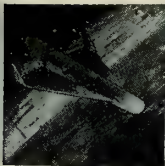


SEPTEMBER, 1961

# MISSILES and ROCKETS

# ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



## Satellites and Spacecraft

| PROJECT                            | CONTRACTORS                                                                                                                   | DESCRIPTION                                                                                                                                    | STATUS                                                                                                                                                                                        |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ADVENT</b> (Army)               | Army Signal Corps, prime; Bendix prime for 24-hour satellite communications package; GE, vehicle                              | Twenty-four hour instantaneous repeater communications satellite; more than 1250 lbs.; program incorporates Projects STEER, DECREE and COURIER | R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first ATLAS-CENTAUR launchings late '62; may use TITAN II space booster |
| <b>ANNA</b> (Army, Navy, AF, NASA) | No contractors announced                                                                                                      | Geodetic satellite; 50-100 lbs.; probably spherical                                                                                            | Study completed; R&D program appears imminent                                                                                                                                                 |
| <b>AEROS</b> (NASA)                | No contract announced                                                                                                         | 24-hour weather satellite to be boosted by CENTAUR                                                                                             | Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon                                                                                         |
| <b>★APOLLO</b> (NASA)              | MIT, guidance                                                                                                                 | Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN                  | Convair, GE, Martin studies completed; spacecraft bids for accelerated program due Oct. 9; awards due by year-end                                                                             |
| <b>ARENTS</b> (ARPA)               | Convair, prime                                                                                                                | Satellites to investigate deep space; 22,000 m. orbits; ATLAS-CENTAUR booster                                                                  | Contract let to build three payloads; launchings begin early '62                                                                                                                              |
| <b>ASP</b> (Air Force)             | No contracts announced                                                                                                        | Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space                                                          | Study                                                                                                                                                                                         |
| <b>BAMBI</b> (ARPA)                | Convair, STL                                                                                                                  | Satellite system capable of intercepting enemy missiles in boost phase                                                                         | Studies                                                                                                                                                                                       |
| <b>CSAR</b> (Air Force)            | No contracts announced                                                                                                        | Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors                                         | Studies; possibly operational mid-60's                                                                                                                                                        |
| <b>★DISCOVERER</b> (Air Force)     | Lockheed, prime; GE, re-entry vehicle                                                                                         | THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems            | Launchings: 28; 6 capsules recovered from orbit (4 air-snatched) after orbiting earth one to three days; plans to put simians in capsules scrapped.                                           |
| <b>★DYNA-SOAR I</b> (Air Force)    | Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link | Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN II booster; 3rd powered stage to be added                             | R&D; first glider flights from Edwards AFB 1962; R&D suborbital flight about early 1965; program accelerated somewhat under FY '62 budget; further acceleration under consideration           |
| <b>ECHO</b> (NASA)                 | Langley Research Center, prime                                                                                                | ECHO I: 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; ECHO II: 135-ft., 700-mi. orbit                         | In orbit since Aug. 12, 1960; ECHO II scheduled to be launched 1962; sub-orbital tests late '61                                                                                               |

★ Indicates changes since July, 1961, Astrolog



| PROJECT                                    | CONTRACTORS                                                                        | DESCRIPTION                                                                                                                                                               | STATUS                                                                                                                                                                                                                                                                   |
|--------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>MARINER (NASA)</b>                      | JPL, prime                                                                         | 600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B                                                                              | Seven shots planned. First scheduled Venus fly-by Aug. 1962                                                                                                                                                                                                              |
| <b>★MERCURY (NASA)</b>                     | McDonnell, capsule                                                                 | First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket)                                                                                                | First manned orbit shot expected late 1961 or early 1962. Sub-orbited launchings with REDSTONE ended after two successes; at least two orbital shots (one with simian), to precede manned shot                                                                           |
| <b>★MIDAS (Air Force)</b>                  | Lockheed, prime; Aerojet, IR detector system                                       | Early-warning satellite; detect ICBM launchings by IR before birds leave pad; R&D models weigh 2.5 tons; operational system 12-15 satellites                              | R&D; second launching May 24, 1960 partial success; MIDAS III successfully launched July 12, components being tested by DISCOVERER                                                                                                                                       |
| <b>NIMBUS (NASA)</b>                       | GE, prime                                                                          | 2nd generation weather satellite; 650 lbs.; 6 TV cameras in payload; THOR-AGENA B booster                                                                                 | First launching scheduled for late 1962                                                                                                                                                                                                                                  |
| <b>OAO (NASA)</b>                          | Grumman, prime; Westinghouse, electronic components; GE, stabilization and control | 3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B                                                                    | First flight scheduled in late 1963 or 1964                                                                                                                                                                                                                              |
| <b>OGO (NASA)</b>                          | Space Technology Laboratories, prime                                               | 1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters          | First flight scheduled in 1963                                                                                                                                                                                                                                           |
| <b>★OSO (NASA)</b>                         | Ball Brothers, prime                                                               | 440-lb. orbiting solar observatory; THOR-DELTA booster; S-16                                                                                                              | First flight planned this fall for S-16; first flight for S-17 planned for 1962                                                                                                                                                                                          |
| <b>PROSPECTOR (NASA)</b>                   | No contract announced                                                              | Soft-landed, remote control, unmanned moon exploring spacecraft; SATURN booster                                                                                           | First flight planned by 1965; study contracts to be awarded in 1961                                                                                                                                                                                                      |
| <b>★RANGER (NASA)</b>                      | JPL, prime; Aeronutronic, capsule; Hercules, retrorocket                           | 300-lb. instrumented capsule rough landed on moon; ATLAS-AGENA B booster                                                                                                  | R&D; first flight Aug. 23, RANGER failed to launch from orbit; next shot Oct.; first lunar landing planned for 1962.                                                                                                                                                     |
| <b>REBOUND (NASA)</b>                      | No contract announced                                                              | System of 3 to 6 multi-launched ECHO II communications satellites                                                                                                         | First orbital flight scheduled for 1963 or 1964                                                                                                                                                                                                                          |
| <b>★RELAY (NASA)</b>                       | RCA, prime                                                                         | 100-lb. active repeater communications satellites. Commercial system planned; DELTA launched                                                                              | Both Britain and France to take part in program; Latin American interest sought; first launching next year                                                                                                                                                               |
| <b>SAINT (Air Force)</b>                   | RCA, prime                                                                         | Anti-satellite satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS launched                                                       | R&D underway; to be launched against reflectors or balloons in 400-mi. orbits late '61                                                                                                                                                                                   |
| <b>★SAMOS (Air Force)</b>                  | Lockheed, prime                                                                    | Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.                                                                                                     | R&D; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; components being tested in DISCOVERERS; advanced SAMOS under development                                                                                             |
| <b>SLOMAR (Air Force)</b>                  | Lockheed and Martin, prime                                                         | Logistics, maintenance, supply spacecraft for space systems                                                                                                               | Study contracts awarded in December                                                                                                                                                                                                                                      |
| <b>SURVEYOR (NASA)</b>                     | Hughes, prime                                                                      | 750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster                                                                                   | First moon flights 1963; seven or more to be launched by 1965                                                                                                                                                                                                            |
| <b>SYNCOM (NASA)</b>                       | Hughes, prime                                                                      | 24-hr. instantaneous repeater communications satellite.                                                                                                                   | R&D; first launching scheduled late 1962                                                                                                                                                                                                                                 |
| <b>★TIROS (NASA-AF-Army-Navy-Wea. Bu.)</b> | RCA-Army Signal Corps, prime                                                       | Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner                                                                                         | R&D; first launching last April; second Nov. 23; third July 12, all successful; two more planned                                                                                                                                                                         |
| <b>★TRANSIT (Navy)</b>                     | Applied Physics Laboratory, prime                                                  | Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.                                                                          | TRANSIT IB R&D satellite in orbit April 13, 1960; IIA plus piggyback satellite in orbit June 22; TRANSIT IIIB launched into poor orbit Feb. 21; IVA orbited June 29 with 2 piggy-back payloads that failed to separate; 4-satellite system scheduled to be in orbit 1962 |
| <b>VOYAGER (NASA)</b>                      | No contract announced                                                              | Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster                                                                                    | Study; first flight planned by 1965                                                                                                                                                                                                                                      |
| <b>YO YO (Navy)</b>                        | No contract announced                                                              | Tactical sea-launched one-pass reconnaissance satellite                                                                                                                   | R&D                                                                                                                                                                                                                                                                      |
| <b>X-15 (NASA-AF-Navy)</b>                 | North American, prime; Thiokol, propulsion                                         | Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-II rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered. | Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-II engine; plane #2 with XLR-99 engine turned over to NASA; has hit 3690 mph speed record; altitude record of 169,600 ft. (unofficial for manned, powered flight)                |





# Missiles and Rockets

| PROJECT                         | CONTRACTORS                                                                                               | DESCRIPTION                                                                                                                                                                                                              | STATUS                                                                                                                                                                                                                                                |
|---------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ALFA</b> (Navy)              | Navy, prime; Avco, air frame                                                                              | ASW surface-to-underwater; 500 lb. solid; conventional                                                                                                                                                                   | Deployed on destroyer escorts                                                                                                                                                                                                                         |
| <b>ARM</b> (Navy)               | No contract announced                                                                                     | Anti-radar missile; air to surface                                                                                                                                                                                       | R&D; AF anti-radar missile by same name at least temporarily shelved                                                                                                                                                                                  |
| <b>ASROC</b> (Navy)             | Minneapolis-Honeywell, prime; Sanguamo Electric, sonar; torpedo, GE; depth charge, M-H                    | Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D                                                           | Operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers                                                                                                                                    |
| <b>ASTOR</b> (Navy)             | Westinghouse, prime                                                                                       | ASW underwater to underwater rocket torpedo; nuclear                                                                                                                                                                     | R&D                                                                                                                                                                                                                                                   |
| <b>*ATLAS</b> (Air Force)       | Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle           | ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability | 93 launchings; 62 successes, 21 partial, 10 failures; 11 bases for 13 squadrons; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 18 to 21 launchers operational—40 to 60 expected in 1961. First successful "E" shot Feb. 24 |
| <b>BOMARC-A</b> (Air Force)     | Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion                                  | Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear                                                                                                                                       | Five bases operational in Northeastern U.S. from Virginia to Maine                                                                                                                                                                                    |
| <b>*BOMARC-B</b> (Air Force)    | Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion                         | Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear                                                                                                                                         | Operational; a B test bird intercepted simulated target 345 miles away Oct. 14; being deployed at 6 U.S. bases, two in Canada                                                                                                                         |
| <b>BULLPUP</b> (Navy-Air Force) | Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime | Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)                    | Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters                                                                                                  |
| <b>COBRA</b> (Navy)             | No contract announced                                                                                     | Anti-ship radar missile                                                                                                                                                                                                  | Early R&D                                                                                                                                                                                                                                             |
| <b>COBRA</b> (Marines)          | Boelkow Entwicklungen, West Germany, prime manufacturer; Daystrom, U.S. licensee                          | 20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant                                                                                                                                              | Marines planning to purchase; Army considering them; already operational with West German troops                                                                                                                                                      |
| <b>CORPORAL</b> (Army)          | Firestone, prime; Gilfillan, guidance; Ryan, propulsion                                                   | Surface - to - surface; 75-mile range; liquid; nuclear                                                                                                                                                                   | Deployed with U.S. & NATO troops in Europe                                                                                                                                                                                                            |
| <b>CROW</b> (Navy)              | No contract announced                                                                                     | Air-to-air missile                                                                                                                                                                                                       | R&D; has been flight tested                                                                                                                                                                                                                           |
| <b>DAVY CROCKETT</b> (Army)     | In-house project directed by Rock Island, Ill., arsenal                                                   | Surface - to - surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men                                                  | Late R&D; deployment delayed until 1962                                                                                                                                                                                                               |
| <b>ENTAC</b> (Army)             | Nord Aviation, prime                                                                                      | Anti-tank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided.                                                                                                                                                             | Operational; Army buying from French in quantity                                                                                                                                                                                                      |
| <b>FABMIDS</b> (Army)           | Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies                                       | Mobile anti-missile defense system                                                                                                                                                                                       | Each of six contractors have \$250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61                                                                                                                                          |
| <b>*FALCON</b> (Air Force)      | Hughes, prime; Hughes, guidance; Thiokol, propulsion                                                      | Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 model has nuclear warhead                                                                                                                                  | Operational; buy-out of GAR 3A, 4A and 11 in FY '62                                                                                                                                                                                                   |
| <b>GENIE</b> (Air Force)        | Douglas, prime; Aerojet-General, propulsion                                                               | Air-to-air unguided; 1.5-mile range; nuclear                                                                                                                                                                             | Operational                                                                                                                                                                                                                                           |
| <b>GIMLET</b> (Navy)            | No contract announced                                                                                     | Air-to-surface; unguided; considered highly accurate                                                                                                                                                                     | R&D                                                                                                                                                                                                                                                   |
| <b>*HAWK</b> (Army)             | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion                                          | Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes                                                                                                                                    | Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions), SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another                                                    |



| PROJECT                        | CONTRACTORS                                                                                                                                                                              | DESCRIPTION                                                                                                                                                     | STATUS                                                                                                                                                                                                                                                                                       |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ★ <b>HONEST JOHN</b> (Army)    | Douglas/Emerson Electric, prime; Hercules, propulsion                                                                                                                                    | Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter                                        | Operational; deployed in Europe                                                                                                                                                                                                                                                              |
| <b>HOUND DOG</b> (Air Force)   | North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion                                                                                                               | Air breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear                                                                                       | Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400                                                                                                                                                                                            |
| ★ <b>JUPITER</b> (Army)        | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle                                                                                       | IRBM; liquid; nuclear; can be made mobile                                                                                                                       | Operational in Italy (30 launchers) with Italian AF; being deployed in Turkey; 32 military launchings: 25 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape.                                                                                |
| <b>LACROSSE</b> (Army)         | Martin, prime; Martin, guidance; Thiokol, propulsion                                                                                                                                     | Surface-to-surface; highly mobile; 20-mile range; solid; nuclear                                                                                                | Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped                                                                                                                                                                                               |
| <b>LAW</b> (Army)              | Hesse-Eastern Div., Flightex Fabrics, prime                                                                                                                                              | Light anti-tank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter                                                                             | R&D under AOMC                                                                                                                                                                                                                                                                               |
| <b>LITTLE JOHN</b> (Army)      | Emerson Electric, prime; Hercules Powder, propulsion                                                                                                                                     | Surface-to-surface; unguided; 10-mile range; solid; nuclear                                                                                                     | First 4-launcher battalion operational this winter                                                                                                                                                                                                                                           |
| <b>LOBBER</b> (Army)           | No contract announced                                                                                                                                                                    | Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BAL-LISTA                                                 | Studies                                                                                                                                                                                                                                                                                      |
| <b>LULU</b> (Navy)             | General Mills/Naval Ordnance Lab, prime                                                                                                                                                  | Small nuclear depth charge air-dropped or launched by ASROC                                                                                                     | Operational                                                                                                                                                                                                                                                                                  |
| <b>MACE</b> (Air Force)        | Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion                                                                                                             | Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid-nuclear; B model has more than 1200 mile range                                     | Being deployed with U.S. troops in West Germany; now all mobile but hard-base version development completed; to be in Okinawa, Korea                                                                                                                                                         |
| <b>MATADOR</b> (Air Force)     | Martin, prime; Thiokol/Allison, propulsion                                                                                                                                               | Air-breathing surface-to-surface; 650 mile range                                                                                                                | Being turned over to West Germans; also deployed in Far East                                                                                                                                                                                                                                 |
| <b>MAULER</b> (Army)           | Convair, prime                                                                                                                                                                           | Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher                  | R&D; NATO may buy                                                                                                                                                                                                                                                                            |
| ★ <b>MINUTEMAN</b> (Air Force) | Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF, rail launcher | 2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages                                                                           | R&D; scheduled to be operational mid-1962 at Malmstrom AFB; 3 Launchings: 2 successful, 1 partial; tactical rail system tests completed; 3 squadrons at Malmstrom, Mont.; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D. 12 fixed squadrons now planned; mobile system indefinitely postponed |
| <b>M-55</b> (Army)             | Norris Thermador, prime                                                                                                                                                                  | Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers                                                                   | Operational                                                                                                                                                                                                                                                                                  |
| <b>MISSILE A</b> (Army)        | ARGMA, prime                                                                                                                                                                             | Surface-to-surface; 10-20 mile range; solid                                                                                                                     | Design studies                                                                                                                                                                                                                                                                               |
| ★ <b>MISSILE B</b> (Army)      | No contractors announced                                                                                                                                                                 | A highly mobile general purpose missile; range 30-50 miles.                                                                                                     | Study                                                                                                                                                                                                                                                                                        |
| <b>NIKE-AJAX</b> (Army)        | Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe                                                                                              | Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional                                                                                           | Deployed in U.S., Europe & Far East; about 170 batteries in U.S., sixty-eight more to be phased out and replaced with NIKE-HERCULES                                                                                                                                                          |
| <b>NIKE-HERCULES</b> (Army)    | Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion; Douglas, airframe                                                                                   | Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed                                                              | Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa                                                                                                                                             |
| ★ <b>NIKE-ZEUS</b> (Army)      | Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion; Douglas, airframe                                                                                  | Anti-missile; 3-stage; 200-mile range; solid; nuclear                                                                                                           | R&D test launchings at White Sands, 19 R&D launchings; 11 successful, 6 partial, 2 failures. Full missile tests to begin this month from Ft. Mugu, Calif.; complete system tests now scheduled for early '62                                                                                 |
| ★ <b>PERSHING</b> (Army)       | Martin, prime; Bendix, guidance; Thiokol, propulsion                                                                                                                                     | Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range | R&D; to replace REDSTONE; 21 R&D launchings; 17 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 4 failures. Operational late 1961; R&D launching about 250 miles April 21                                                                            |

| PROJECT                     | CONTRACTORS                                                                                                 | DESCRIPTION                                                                                                                                                                                                                                       | STATUS                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ★POLARIS (Navy)             | Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle | Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D; possible A-4 4000-5000 mile range missile under study | 99 launchings of test vehicles; 69 successes; 24 partial; 6 failures; 31 also launched from submerged subs—all cleared surface; 21 successful flights, 10 failures. Four subs each with 16 missiles operational, 5th deploying imminently. Total authorized by White House: 29. POLARISES for cruiser Long Beach cancelled; Polaris II R&D missiles impacting 1400+ n.mi. in guided flight |
| QUAIL (Air Force)           | McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment                    | ECM-carrying bomber decoy; about 200 m. range; jet powered                                                                                                                                                                                        | Deployed at SAC bases; carried by B-52                                                                                                                                                                                                                                                                                                                                                     |
| RAVEN (Navy)                | No contract announced                                                                                       | Air-to-surface; about 500-mile range                                                                                                                                                                                                              | Study                                                                                                                                                                                                                                                                                                                                                                                      |
| REDEYE (Army)               | Convair, prime; Philco/Convair Atlantic Research, propulsion                                                | Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable                                                                                                                                      | Late R&D; deployment delayed until late 1962; Marines also will use; NATO may buy                                                                                                                                                                                                                                                                                                          |
| REDSTONE (Army)             | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion                                          | Surface-to-surface; liquid; 200-mile range; nuclear                                                                                                                                                                                               | Deployed with U.S. troops in Europe; to be replaced by PERSHING                                                                                                                                                                                                                                                                                                                            |
| REGULUS I (Navy)            | Chance Vought, prime and guidance; Aerojet-General, propulsion                                              | Surface-to-surface; turbojet & solid; 500-mile range; nuclear                                                                                                                                                                                     | Deployed aboard U.S. submarines; REGULUS II used as target drone                                                                                                                                                                                                                                                                                                                           |
| SEMPER (Marines)            | No contracts announced                                                                                      | Believed to be an air-launched missile                                                                                                                                                                                                            | R&D testing at Ft. Mugu                                                                                                                                                                                                                                                                                                                                                                    |
| SERGEANT (Army)             | Sperry, prime; Sperry, guidance; Thiokol, propulsion                                                        | Surface-to-surface; solid; more than 75-mile range; nuclear                                                                                                                                                                                       | In production                                                                                                                                                                                                                                                                                                                                                                              |
| ★SHILLELAGH (Army)          | Aeronutronic, prime                                                                                         | Surface-to-surface; lightweight; can be vehicle-mounted                                                                                                                                                                                           | R&D                                                                                                                                                                                                                                                                                                                                                                                        |
| SIDEWINDER (Navy-Air Force) | GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion                                        | Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads                                                                                                                       | Deployed with Navy and Air Force; all-weather type under development                                                                                                                                                                                                                                                                                                                       |
| SKYBOLT (Air Force)         | Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle                             | ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers                                                                                                                                                | R&D; to be purchased by British; operational 1964; test-launching to be from Eglin AFB, Fla. Add. funding restores old operational date                                                                                                                                                                                                                                                    |
| SLAM (Air Force)            | No contract announced                                                                                       | Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead                                                                                                                                                                          | Study-R&D                                                                                                                                                                                                                                                                                                                                                                                  |
| SPARROW III (Navy)          | Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion                                    | Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional                                                                                                                                                               | Operational with carrier aircraft earlier SPARROW I obsolete; new contract extending range, altitude                                                                                                                                                                                                                                                                                       |
| SUBROC (Navy)               | Goodyear, prime; Kearfott, guidance; Thiokol, propulsion                                                    | Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear                                                                                                                                                                             | Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine                                                                                                                                                                                                                                                                                       |
| ★SS-10 (Army)               | Nord Aviation, prime; GE, U.S. licensee                                                                     | Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional                                                                                                                                                | Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. Army phasing it out                                                                                                                                                                                                                                                                    |
| ★SS-11 (Army)               | Nord Aviation, prime; G.E., U.S. licensee                                                                   | Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional                                                                                                                                                | Operational, to be used with airborne units                                                                                                                                                                                                                                                                                                                                                |
| TALOS (Navy)                | Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion                                  | Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear                                                                                                                                                                              | Operational aboard cruiser Galveston                                                                                                                                                                                                                                                                                                                                                       |
| TARTAR (Navy)               | Convair, prime; Raytheon, guidance; Aerojet-General, propulsion                                             | Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional                                                                                                                                   | Operational on Missile Destroyer Adams in Oct.                                                                                                                                                                                                                                                                                                                                             |
| TERNE (Navy)                | Kongsberg Vapenfabrikk, prime; Arma, systems integration                                                    | Surface-to-underwater ASW missile; 264 lbs; HE warhead                                                                                                                                                                                            | Navy buying from Norway to equip two destroyer escorts                                                                                                                                                                                                                                                                                                                                     |
| TERRIER (Navy)              | Convair, prime; Reeves/FTL, Sperry guidance; ABL, propulsion                                                | Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional                                                                                                                                                                         | Operational with fleet                                                                                                                                                                                                                                                                                                                                                                     |
| TERRIER-ADVANCED (Navy)     | Convair, prime; Reeves/FTL, Sperry guidance; ABL, propulsion                                                | About 100% performance improvement over TERRIER                                                                                                                                                                                                   | Operational with fleet; being deployed on destroyers and carriers                                                                                                                                                                                                                                                                                                                          |
| ★THOR (Air Force)           | Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle                        | Surface-to-surface IRBM; 1500-mile range; liquid; nuclear                                                                                                                                                                                         | Operational; 4 bases (60 launchers) set up in England. 67 military launchings: 46 successes; 11 partial; 10 failures. 56 scientific launchings: 47 successful, 2 partial; 7 failures                                                                                                                                                                                                       |

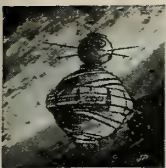


| PROJECT             | CONTRACTORS                                                                                                                                                                | DESCRIPTION                                                                                                                                                                                                               | STATUS                                                                                                                                                                                                                                                                                   |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ★TITAN (Air Force)  | Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle | Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed | 38 launchings test vehicles: 26 successes; 8 partial; 4 failures. 8 bases for 12 squadrons planned; TITAN I scheduled to be operational mid-1961; TITAN II scheduled operational early 1963; TITAN I successfully launched from TITAN II silo; first TITAN II test scheduled in November |
| TYPHON (Navy)       | Westinghouse, prime; Bendix propulsion                                                                                                                                     | Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic                                                          | Early R&D; may be used on hydrofoil destroyers                                                                                                                                                                                                                                           |
| WAGTAIL (Air Force) | Minneapolis-Honeywell, prime                                                                                                                                               | Family of airborne RLM's (rear-launched missiles); air-to-air and air-to-surface                                                                                                                                          | Late R&D                                                                                                                                                                                                                                                                                 |
| WILLOW (Army)       | Chrysler, prime                                                                                                                                                            | Highly-classified missile                                                                                                                                                                                                 | R&D                                                                                                                                                                                                                                                                                      |
| ZUNI (Navy)         | Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion                                                                                                             | Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional                                                                                                                                                     | Operational                                                                                                                                                                                                                                                                              |



## Space Vehicles

|                                |                                                                                                                                                      |                                                                                                                                                                           |                                                                                                                                                                     |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AGENA (Air Force)              | Lockheed, prime; Bell, propulsion                                                                                                                    | 1700-pound satellite after burnout; AGENA B stop-start 2450-lb. engine; about double fuel capacity of AGENA A                                                             | Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR                                                                                      |
| BLUE SCOUT (Air Force)         | Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion                                                          | Solid multi-stage booster based on SCOUT components                                                                                                                       | Operational                                                                                                                                                         |
| CENTAUR (NASA)                 | Convair, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance                                                                         | Pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.                             | First test flight in 1961; first engine delivered                                                                                                                   |
| DELTA (NASA)                   | Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion                                                                                 | Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity                                                                                                    | Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe                                                                     |
| ★NOVA-L (NASA)                 | No prime announced; Rocketdyne, propulsion                                                                                                           | Clustered 6-12 million lb. liquid propellant booster plus upper stages                                                                                                    | R&D on 1.5 million lb. F-1 engines; vehicle contract expected to be awarded this fall; F-1 test-fired 19 times at more than 1 million lbs. thrust                   |
| NOVA-S (Air Force)             | No contractor announced; expected to be based on Aerojet/Grand Central feasibility studies                                                           | Clustered 12-million—20-million-lb. booster; possible alternative to NOVA-L                                                                                               | R&D; contracts expected to be let shortly                                                                                                                           |
| ORION (Air Force)              | General Atomic                                                                                                                                       | Space booster launched by series of atomic explosions                                                                                                                     | Advanced engineering studies underway; tests may be attempted                                                                                                       |
| PHOENIX (Air Force)            | No contracts announced                                                                                                                               | Recoverable booster—possibly a modified F-1                                                                                                                               | Studies                                                                                                                                                             |
| ★ROVER (NASA, AEC)             | Aerojet, prime                                                                                                                                       | First nuclear rocket: KIWI non-flying test engines and NERVA flight engines                                                                                               | First hot run of KIWI-B test unit at Nevada test site in October                                                                                                    |
| ★SATURN (NASA)                 | Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines | Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload | First SATURN booster being readied for first launching in Oct. at Cape; flight with live upper stages scheduled 1963. C-2 killed, C-3 to have 2 F-1's in 1st stage. |
| SCOUT (NASA)                   | Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion                                              | Solid four-stage satellite launcher; 200 lb. payload in orbit                                                                                                             | SCOUT flights in '61 completes R&D; Navy proposing SEASCOUT for sea-borne surface launch, would be based on POLARIS and SCOUT                                       |
| THOR-ABLESTAR (Air Force-NASA) | STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion                                                                                               | Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine                                                                                           | THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER                                                                                              |



# Satellites in Orbit

**\*EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 217 m., apogee 1108 m., period 106.4 min. (Discovered Van Allen Belt); not transmitting.

**\*VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 404, apogee 2448, period 133.8; transmitting.

**LUNIK I "MECHTA"** (3245 lbs.) Russia. Launched 1/2/59. Believed to be in orbit around sun on 15-mo. cycle; not transmitting.

**\*VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 344, apogee 2046, period 125.3; inclination to equator 32.88°; not transmitting.

**PIONEER IV** (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun, and achieved primary mission—earth-moon trajectory; not transmitting.

**EXPLORER VI "PADDLEWHEEL"** (142 lbs.) U.S. Launched 8/7/59. Orbits earth; initial perigee 156, initial apogee 26,357, initial period 12½ hrs., present orbit uncertain.

**\*VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 317, apogee 2320, period 129.8; not transmitting.

**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 669, period 101.1; transmitting.

**\*PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9951 au, perihelion .8061 au, not transmitting.

**\*TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 467, period 99.1; transmitting.

**\*TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 412, period 94.9 First R&D navigation satellite. Not transmitting.

**\*SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 191/429 on 5/19/60; last reported—perigee 175, apogee 309, period 92.3 Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

**\*MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 297, apogee 314, period 94.3 Telemetry for IR scanning failed two days after launch. Not transmitting.

**TRANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apogee 649, period 101.6. Transmitting.

**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Not transmitting.

**\*ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 823, apogee 1098, period 116.9. First successful orbiting of passive communications satellite.

**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 604, apogee 750, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

**\*EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 262, apogee 1410, period 112.5. Provides ionospheric measurements for communications. Not transmitting.

**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 461, period 98.2. Transmitting.

**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apogee 342, period 94.9. First R&D reconnaissance satellite.

**\*VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61, aphelion 1.0190 au, perihelion 0.7183 au.

**\*EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 431, apogee 1562, period 118.1. A 12-ft. "polka dot" balloon.

**\*DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 176, apogee 420, period 94.3. No attempt to recover 300-lb. capsule because of malfunction.

**\*DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 154, apogee 524, period 95.6. Carried IR equipment for MIDAS program to measure background radiation from earth.

**EXPLORER X** (78 lbs.) U.S. Launched 3/25/61. Last known position: perigee 110, apogee 112,500, period 5012. Optical-pumping magnetometer. Position uncertain.

**\*DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 183, apogee 349, period 93.2. Capsule ejected in wrong direction, sending it further into space. Not transmitting.

**\*EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth; perigee 302, apogee 1110, period 107.9. Measures gamma rays from the stars absorbed in earth's atmosphere.

**\*TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs., INJUN, 40 lbs.) U.S. Launched 6/29/61. Orbits earth; TRANSIT—perigee 547, apogee 620, period 103.8. GREB-INJUN—perigee 548, apogee 619, period 103.8. Transmitting. GREB III and INJUN failed to separate after three-in-one launch.

**\*DISCOVERER XXVI** (2100 lbs.) U.S. Launched 7/7/61. Orbits earth; perigee 142, apogee 436, period 94.0. Systems evaluation of AGENA B. Capsule recovered.

**\*TIROS III** (285 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 457, apogee 511, period 100.3. Transmitting cloud cover weather pictures.

**\*MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits earth, perigee 2084, apogee 2197, period 161.5. IR early warning satellite.

**\*EXPLORER XII** (83 lbs.) U.S. Launched 8/15/61. Orbits earth; perigee 180, apogee 47,800, period 26½ hours. Study Van Allen belts and energetic particles in space.

**\*RANGER I** (675 lbs.) U.S. Launched 8/23/61. Orbits earth after failing to achieve planned long eccentric orbit; perigee 105, apogee 312, period 91. Experiments operating but not sending desired information on magnetic fields because of near earth orbit.

*(Orbital data is latest official information as of 1200 Z, August 15, 1961)*

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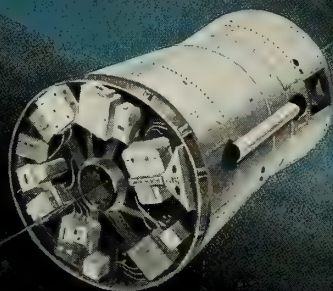
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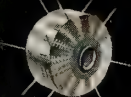
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# Ratemeters Being Developed for Jells

## Use of thixotropic fuels is being brought nearer through techniques explored by AF's Applied Radiation Lab

A MAJOR KEY to future use of thixotropic propellants is the development of a mass flow ratemeter for the jelled mixes. No such instrument is now available.

One promising approach for jelled propellant mass flow rates is the application of gamma ray absorption techniques, according to Capt. R. J. Darby and Lt. J. F. Wakeman, project engineers at the Applied Radiation Laboratory, Liquid Systems Div., Directorate of Rocket Propulsion, Edwards AFB, Calif. Use of this method (Fig. 1) has provided both high- and low-level tank propellant level indications.

The system uses collimated Cesium-137 sources together with a Geiger-Mueller detector operating through a ratemeter and a switching circuit. (Fig. 1). The high-level detector automatically closes the solenoid-operated propellant fill valve, and the low-level detector automatically cuts off engine firing at a predetermined tank level.

• **Highly accurate**—Because of the slow rate of tank filling, the high-level detector makes it possible to control propellant level in the run tanks to

$\pm 0.125$  in.—or an overall accuracy of  $\pm 0.2\%$  in relation to the total fuel mass of the tank being employed.

The low-level detector circuit, which controls the main propellant run valves, shuts off the engine at a propellant level of approximately one inch below the detector source location.

The one-inch overrun represents a system lag of approximately one-half second. The lag is due primarily to the time constant of the ratemeter plus the time delays of the solenoid-operated valves. The one-inch lag, however, is both predictable and reproducible, resulting in a tank level accuracy of  $\pm 0.250$  in. at the predetermined point of engine cutoff. The latter figure represents  $\pm 0.4\%$  of the tank's total propellant.

Although the system was built primarily for accurate tank filling and for an approximate engine cut-off point in relation to propellant remaining, it also provides an approximate overall mass flow rate for the engine during the firing time. Another function of the system is to furnish test personnel with a means of calculating overall engine parameters.

Improvements in the ratemeter switching system and relays, and the ratemeter time constant, are expected to provide even higher accuracies in the system.

• **Another approach**—Atomics International Division of North American Aviation is currently conducting a study program for the Applied Radiation Lab to develop ARL's existing propellant

utilization system for further flow studies of thixotropic propellants.

The approach will consist of a study of multiple Cesium-137 source locations so as to provide a linear output signal proportional to the propellant mass remaining in the tanks at any given time. (Fig. 2).

AI will also study the possibility of using a newly developed, high-signal-to-noise ratio photomultiplier tube to give an analog voltage output. Successful use of the tube, produced by the Schlumberger Co., would enable AI to construct an instantaneous mass flow meter with accuracies on the order of  $\pm 2\%$ .

• **Jells promising**—Thixotropic propellant development has been under way for some time at the Directorate of Rocket Propulsion, under the overall propellant study of Project Joshua. Advantages claimed for the jelled propellant approach include a reduction in handling problems, a decreased rate of vaporization and a minimum amount of leakage during transfer operations.

The Edwards unit has fired some jelled-propellant small rocket motors with good results, but there are still many operational problems to be solved—pumping of the propellant jell, tank filling as well as propellant mass flow measurement.

The Directorate of Rocket Propulsion has been studying and working with monopropellant jells and has recently constructed facilities for test of thixotropic propellants in motors of up to 5000 lbs. thrust. ■

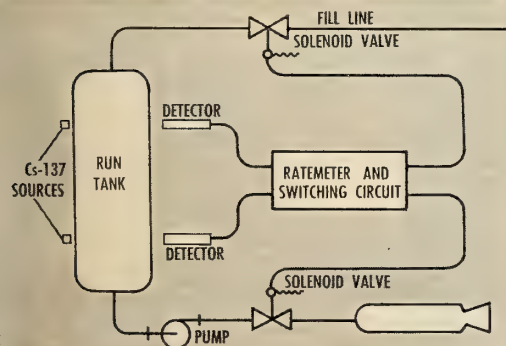


FIG. 1—Collimated Cesium-137 sources with Geiger-Mueller detector operating through ratemeter and switching circuit.

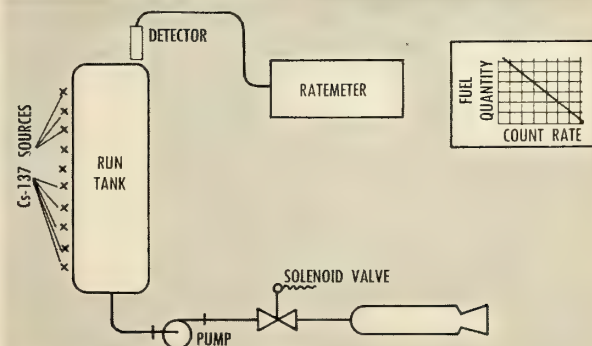


FIG. 2—Multiple Cesium-137 sources provide linear output signal proportional to mass remaining in tanks.



# A-G Looks for Big Solid Test Site

**Areas in Florida, Texas and on West Coast considered as possibilities; million-lb. firing to close test series?**

by Frank G. McGuire

AEROJET-GENERAL is actively seeking a new site for the development and testing of large solid-propellant boosters. The facility is expected to sprawl over between 25,000 and 80,000 acres.

The actual spot will be chosen within 90 days. It will have to be near the ocean and a large metropolitan center, have adequate water and transport, and meet several other requirements.

Teams from the firm have studied possible areas in Dade County, Fla., Corpus Christi, Tex. and three West Coast sites. Aerojet's Executive Vice President W. E. Zisch says the site will be used for large boosters only; this effectively squelches any speculation that the firm intends to switch a significant share of its work out of Sacramento.

Best bet to head up the new facility is Dr. E. R. Roberts, director of the large solid work at Sacramento. Although no official statement has been made, Roberts conceded he "might have some sort of significant part" in the projected setup.

First indications of such a move came at the announcement of the formation of Space-General Corp., a subsidiary of Aerojet-General. (M/R, July 3, p. 16).

• "Go for broke?"—Elsewhere on

the booster front, Aerojet is preparing for the fifth and final test in the large-solid feasibility program currently being conducted for the Air Force Space Systems Division.

Final objectives for this test have not yet been spelled out but there is speculation that the Air Force may "go for broke"—as with the first full-scale *Minuteman* firing—and try for the full million-lb. thrust, 90-second firing.

The four-segment FW-2 motor generated just under 500,000 lbs. thrust in its most recent firing, on Aug. 26. It burned for 87 seconds. This entire motor is expected to be involved in the final test, but with one more segment added. A freon-injection thrust-vector control system will also be included.

During the last test, the burning rate in the four-segment motor was determined through radioisotopes. Company technicians carefully placed pellets containing radioactive material at nine different locations in the propellant mass.

The pellets, provided by Aerojet-Nucleonics, were coated with propellant and then given a special covering.

Detectors located around the motor were able to sample radiation from the pellets—and transmit the changed radiation count as the pellets were destroyed by the advancing burning surface.

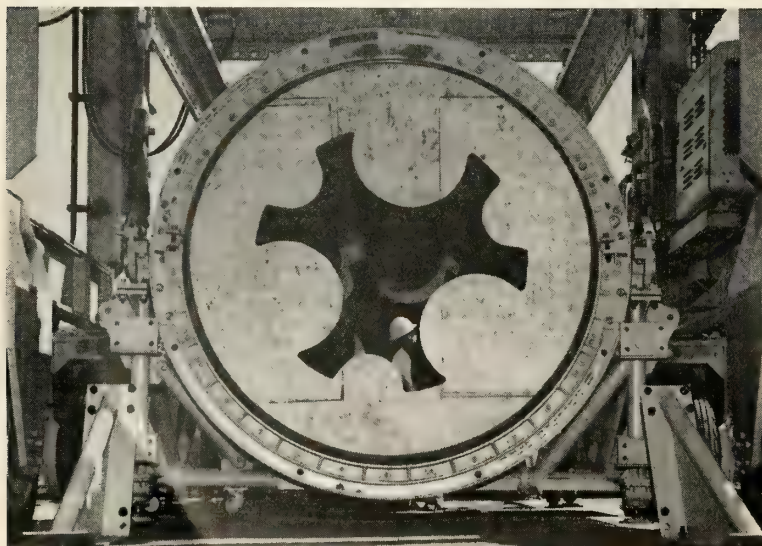
Company spokesmen said the burning rate has been precisely determined with this technique, and the low-energy pellets provide just enough radiation to do their job without endangering personnel.

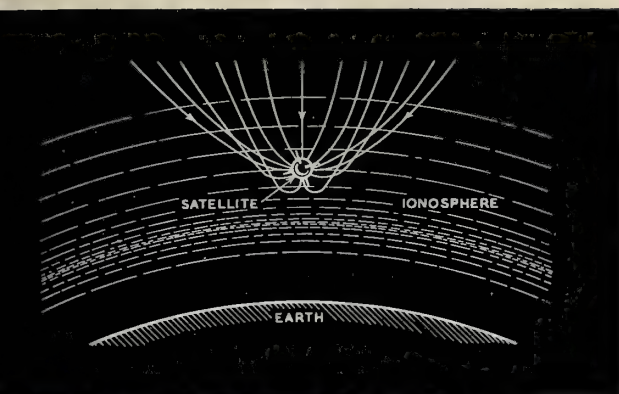
About 80 tons of propellant was involved in the FW-2 firing. Motor length was 42 ft., diameter 100 in. The segments were given a restrictive coating on the ends of the propellants to prevent end burning and an intolerable pressure increase.

A stationary plastic nozzle with a carbon throat insert was used and no thrust vector control was tested. Nozzle char was relatively light and no undue damage was observed.

Acoustical level was estimated by Aerojet officials to be approximately that of the *Titan II* first-stage engine. They said no problems have been encountered with acoustical levels in engine tests. Case wall thickness was not revealed, but company officials said it was not unusually thin. ■■

**BELOW:** Cross-section configuration of the 100-in. Aerojet segment is revealed as components are mated on the test stand. The second center chamber segment is visible behind the technician.





RAY FOCUSING of light from space by the ionosphere.



RECEPTION PATTERN of elementary dipole above F layer.

## electronics

# Using Earth in Huge Antenna System

THE FOLLOWING ARTICLE was extracted from the July issue of *British Communications and Electronics*. Originally titled "Radio Astronomy from Space Vehicles," it was written by R. C. Jennison, B.Sc., Ph.D., F.R.A.S., of the University of Manchester and Nuffield Astronomy Laboratories, Jodrell Bank, Cheshire, England.

EMPLOYING the earth and its ionosphere as part of a vast antenna system may make it possible to broaden the horizons of the radio astronomer to include observations of the electromagnetic spectrum below 15 mc.

Previously, except for the rather uncertain measures of sky brightness by Reber and Ellis at frequencies between 0.5 and 5.0 mc, observations have been limited by the interference of the earth's ionosphere and terrestrial noise.

The resolving power of a telescope to study these low frequencies would have to be approximately 1500 times that of the largest radio telescope at Jodrell Bank. Thus, an earth-based system appears to be completely unfeasible. The same considerations of antenna size make it impractical to carry the telescope system into space.

However, by locating some object many wavelengths across which may be persuaded to function as part of the antenna system—the earth and its ionosphere—it is possible to solve the problem.

There are two equivalent ways of regarding the combination of an elementary antenna and the earth's ionosphere. Both involve earth-orbiting satellites. However, in one system, the

satellite would be above the ionosphere while, in the second, the satellite would be within the ionized medium.

• **System functioning**—In the latter system, the refractive medium, whose refractive index decreases and becomes zero at the critical height above the F layer, bends the ray paths to the small satellite area so that the reception angle is confined to a cone around the satellite. The angle of this cone depends upon the frequency of observation and the electron density at the height of the vehicle.

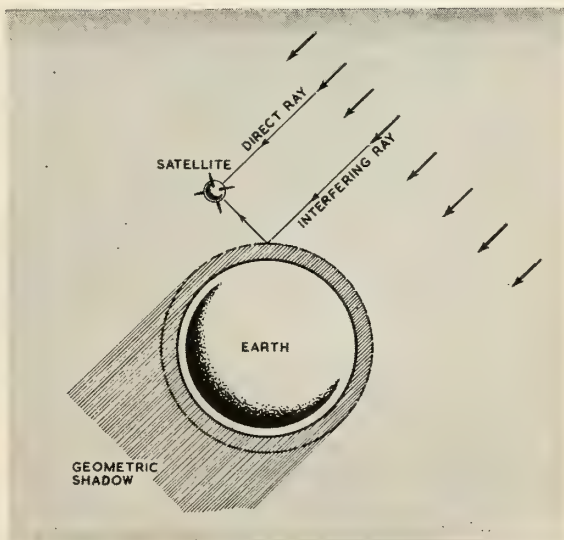
This focusing of the ray paths in the ionosphere can in principle be used as a high-gain antenna, similar to a refracting telescope to map the sky at low frequencies.

Although interference effects would be encountered as a result of a combination of the direct ray and the ionosphere-reflected ray in the higher-orbiting satellite, this system would be no less valuable in low-frequency mapping of the sky. This can be appreciated when the edge of the reception cone is considered as the limit of the earth's

shadow, while the interference caused by the reflection path from the top of the ionosphere results in breaking up the reception pattern within the cone into a number of fine concentric lobes.

These interference lobes may be used as an alternative technique to produce the equivalent of an antenna of gigantic proportions. Sweeping over the sky as the satellite orbits the earth, these lobes may be expected to produce a high-level signal, almost constant in amplitude, from the broad structure of the galactic corona.

• **Output differentiation**—The flux



EFFECTS OF EARTH'S shadow and interference characteristics are shown in drawing of satellite-earth antenna system.



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from individual small bright regions or point sources in the sky would be considerably less than that from the whole sky. Therefore, the telemetry output from the satellite's receiver must be differentiated and the small point sources amplified to a suitable level for transmission to ground stations.

Treated in this manner, the simple dipole aerial system in the satellite is transformed into the primary feed of a vast interferometer type antenna a thousand miles across.

It is likely that at these wavelengths the majority of the signals received will come from the corona of the galaxy where relativistic electrons may emit intense radio waves by a synchrotron process. Thus from the neighborhood of the earth the whole sky may appear bright, with a dark band running along the Milky Way itself, where the clouds of ionized gas of greater density (a few atoms per cubic centimeter) are sufficient to obscure the radiation from greater depths. The well-known radio stars Cassiopeia, Cygnus and Taurus lie close to the plane of the Milky Way; even if they could still radiate at very long wavelengths, they would also be subject to this obscuration.

The quiet sun is not a powerful emitter at long wavelengths, and it would not be prominent. Active bursts from the disturbed sun might, however, produce extremely strong signals. (It is worth noting that the apparent size of the sun at very long wavelengths may be very much greater than in the optical spectrum.)

The planet Jupiter is known to emit very strong bursts, similar to atmospherics, but much more intense, at frequencies close to 20 mc. It is not known if Jupiter or other planets show similar emissions at lower frequencies; this is one of the exciting unknowns in this part of the spectrum.

The discovery of the Jupiter emissions was itself quite unexpected and is a good indication of how unwise it is to try to predict every feature which may be observed over a range of oc-taves as vast as that available to satelliteborne receivers.

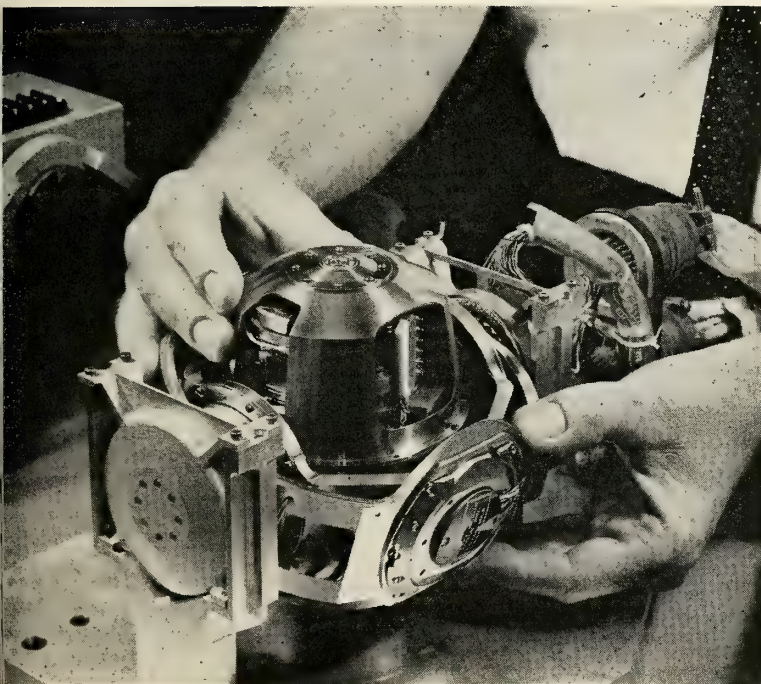
There may be many fascinating new sources of radio waves quite undreamed of in our existing knowledge of the universe. And the earth satellite may be the only practical means of discovering and plotting these sources.

For example, Venus is permanently covered in a layer of ten tenths cloud, preventing optical observations of its surface or lower atmosphere. A satellite-borne spectrometer utilizing the systems outlined above would make it possible to search for water vapor and oxygen bands at 1½ cm and 5 mm respectively by absorption against radiation from the planet's surface. \*\*

# Spaceship Platform Nears Flight Test

*Litton expects to break into missile guidance field with new inertial package scaled down from popular P-200 unit used in aircraft; gas spin bearings employed in gyros*

by Charles D. LaFond



**NEW P-300 inertial reference platform** (shown without cover) weighs 15 lbs. and occupies only 0.2 cu. ft. of space. Platform is a subsystem of an experimental flight data system being developed for the Air Force by Litton Systems, Inc.

BEVERLY HILLS, CALIF.—A new “off-the-shelf” miniature stable platform, developed for Air Force orbital and suborbital space vehicles, will be flight-tested within the next few weeks.

Designated P-300, the 15-lb. 0.2-cu.-ft. inertial package is the first of three subsystems to be completed by Litton Systems, Inc., that will be used to establish feasibility of an integrated Flight Data System. The program, under way for two years, is directed by the Flight Control Laboratory of the Aeronautical Systems Division, Wright Field.

A miniaturized digital computer and air-data sensors will complete the integrated system.

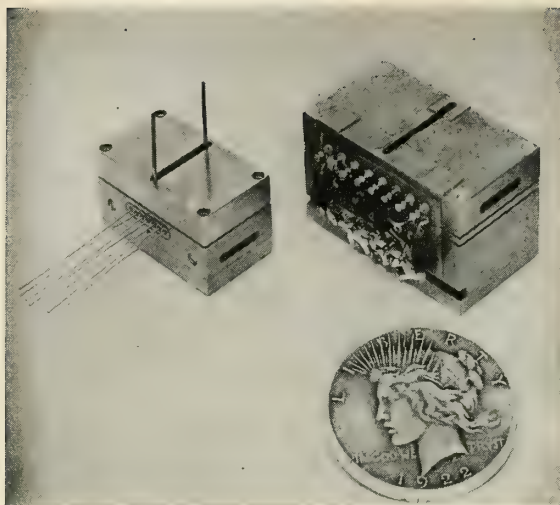
As a result of the contract, the Air Force hopes to prove that such a system can provide all required control data for orbital and suborbital spacecraft. These data are to be supplied during all phases of operation from launch into glide and through re-entry and subsequent recovery.

Litton recently qualified a production platform using similar design features for missile environments on the rocket test sled at Naval Ordnance Test Station, China Lake, Calif. Not now a missile guidance supplier, Litton feels it can successfully break into the field with its new system.

• **Predecessor widely used** — The new platform is a scaled-down version of the widely used P-200 inertial reference unit. More than twice the weight of the minified platform, the Litton P-200 has been ordered by Canada, Belgium, the Netherlands, West Germany and Italy for the F-104 supersonic jet fighter and by the U.S. Navy for the WF-2, W2F, A2F and P3V aircraft. Two somewhat earlier models are to be used in the XB-70 flight tests for altitude reference.

• **P-300 details** — Function of the new platform is to provide measurements of vehicle attitude and acceleration with respect to any desired coordinate system. The stable element employs two beryllium two-degree-of-freedom gyros and three torque-balance accelerometers. The inertial elements are supported by four gimbals which permit unlimited angular freedom of the vehicle about three axes.





*TYPICAL SIZE reduction obtained by Litton in development of its space vehicle guidance package is shown with comparison of accelerometers. The A-300 accelerometer (left) has been made significantly smaller than its predecessor (right), used in the Lockheed F-104 inertial navigation system.*

The three accelerometers are mutually orthogonal and are oriented so that accelerations are sensed along all three axes. Velocity information from the accelerometers is supplied to a digital computer for computation of position and generation of corrective gyro torques. Inertial platform alignment may be accomplished by automatic gyrocompassing or other more newly developed techniques.

The P-300 gyros and accelerometers were both reduced in size and weight from the corresponding P-200 units as a result of Litton's development program. Two-degree-of-freedom gyros again were selected, developers said, enabling a simplification of electronics in comparison with one-degree-of-freedom-gyro platforms. The earlier system used aluminum gyros and geared torquers instead of the present direct-drive torquers.

The complete package measures (roughly) 9.5 in. lg. x 6 in. x 6.5 in.

• **New bearing design**—Gyro size is 2.1 in. x 2.9 in. and weight is less than 2 lbs. The float containing the rotor is approximately 2 in. in diameter.

Despite their small dimensions, Litton says, the P-300G gyros can be supplied with a random drift rate of only 0.001 degree per hour. Other specifications include:

- Mass unbalance—0.01 deg/hr/g
- Anisotropy—0.003 deg/hr/g<sup>2</sup>
- Maximum torquing rate—3000 deg/hr
- Operating life—20,000 hr
- Angular momentum— $0.7 \times 10^6$  gm-cm<sup>2</sup>/sec
- Synchronous speed—24,000 rpm

In the most significant design change, gas spin bearings are employed in the new gyros. Perfection of this technique in itself improved performance of the precision gyro by approximately one

order of magnitude, Litton engineers report. In addition, they believe, precise day-to-day repeatability is improved.

Conceptually, the self-acting, gas lubricated bearing assembly is similar to the oil-lubricated bearings used in large machinery. However, the gaseous lubricant requires a clearance between the bearing surfaces several orders of magnitude smaller than the clearance used in oil-lubricated bearings. Production techniques developed and in use for Litton's LN-3 system, utilizing the P-200 platform, will enable the company to produce the gyros in quantity even though micro-tolerances must be held.

Gas bearings offer four significant features, based on long-term test results:

1) There are no highly-stressed areas. The area supporting the load is approximately 2000 times greater than that of a ball bearing, and the surface stress is lowered accordingly. Reduced stress means a significant reduction in structural creep, resulting in improved day-to-day repeatability.

2) No metal-to-metal contact occurs between the bearing surfaces once the rotor is started. Therefore, no bearing wear occurs during operation of the gyro, and this brings savings in overhaul time and money.

3) Mechanical noise is reduced. In a ball bearing, small irregularities cause appreciable mechanical vibration. In a gas bearing, irregularities do not cause relative movement of the bearing and journal centers because the bearing load is distributed over a large area. Reduction in vibration means a reduction in drift from torque-rectification.

4) Thermal conductivity through a gas-lubricated bearing is much greater than that through an equivalent ball bearing because of the greater contact

surface area. Temperature dispersion is more uniform and thermal gradients are minimized.

Verification of these factors was obtained on drift-tests of the prototype unit. In addition, a gyro rotor was subjected to 85,000 start-stop cycles with no significant signs of wear.

Despite the smaller size of the gyro rotor, high angular momentum is obtained by efficient distribution of rotor mass which provides a large radius of gyration.

Litton points out that many floated gyros, particularly conventional single-degree-of-freedom, rate-integrating types, require appreciable damping. This damping is usually obtained with a flotation fluid of high viscosity, requiring elevated temperature to avoid solidification.

Production problems are introduced because air bubbles must be kept from the fluid while the gyro case is being filled, and thermostatic heating must be provided throughout the life of the gyro. With Litton's gyro design, however, low-viscosity fluid can be used. The flotation fluid selected remains liquid down to approximately -57°C.

The outer case of the gyros was designed to provide more compact stable element packaging, greater ease of assembly, more complete and effective magnetic shielding, and increased case rigidity. The case is hermetically sealed by soldering, and permits minimum expansion coefficient differentials.

• **Small but sensitive**—Although the accelerometers (A-300) for the new inertial reference unit are similar in design to the A-200's used in the P-200 platform, the company asserts that they too have been reduced in size and incorporate significant design improvements. Size is 0.8 x 0.5 x 1.5 in. and weight is 2.6 ounces.

Most sensitive element in all its accelerometers, says Litton, is a floated pendulum mounted on a pair of jewel-and-pivot bearings and equipped with an electro-magnetic pickoff and torquer.

An acceleration of as little as  $2 \times 10^{-5}$  g along the sensitive axis causes the floated pendulum to rotate about its pivot axis. This rotation, however, is immediately sensed by the pickoff, which generates a signal to an external amplifier. The amplifier in turn generates a torquing signal to return the pendulum to zero.

Current required to maintain the pickoff signal at null is a precise function of the applied acceleration.

High pickoff sensitivity and restoring amplifier gain keep the relative motion of the pendulum limited to a small fraction of a milliradian even in the presence of acceleration of over 20g, Litton engineers claim.

They add that scaling down of the

older accelerometer was accomplished with no decrease in sensitivity.

In all the company's accelerometers, the pendulous element is floated to achieve neutral buoyancy at the operating temperature of the flotation fluid. This, Litton feels, reduces the loading on the jewel-and-pivot bearings so that friction becomes negligible. In addition, the flotation fluid provides enough damping to make the balancing servo system relatively easy to stabilize.

In order to absorb the thermal expansion of the small volume of fluid, a miniature aneroid bellows is designed into the accelerometer assembly.

• **Non-gimbal lock**—The gyros and accelerometers for each axis are on a stable element isolated by four gimbals from the rest of the inertial reference unit and, therefore, from the changes in attitude of the vehicle. These give unrestricted maneuverability along any axis.

Gyros are rigidly attached back-to-back, one turned 90 degrees from the other. Thus, a more compact structural configuration replaces the "dumbbell" arrangement of earlier Litton stable elements.

A hermetically sealed cover envelops the stable platform. After the cover is sealed to the base it is filled to standard atmospheric pressure with a mixture of nitrogen and helium. A blower forces air over a heat exchanger mounted in the platform cover for cooling.

• **Electronics unit**—An electronics unit also is considered a component of the P-300 inertial subsystem. The unit contains all the circuitry necessary for operation of the inertial unit and for communication with its digital computer.

The platform electronics unit contains the gimbal servo amplifiers, accelerometer restoring amplifiers, redundant azimuth gyro-axis caging amplifier, power supplies, platform temperature-control circuits, digital converter and switching circuits.

For the flight data system, analog outputs from the accelerometer are converted to binary incremental velocity data for the digital computer. In addition, binary incremental gyro torquing signals from the digital computer are converted to precision pulses for gyro pulse-torquing.

Solid-state circuitry in the electronics unit makes extensive use of d-c amplification to reduce the number of bulky components such as transformers. Using established packaging techniques, the electronics unit—including conversion and pulse torquing circuitry—weighs approximately 18 lbs. and occupies about 0.3 cu. ft. A more advanced version, utilizing micro-circuitry, is expected to have half that weight. ❖

missiles and rockets, September 4, 1961

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# Orbital Fuel Storage Conditions Are

**NASA experts find little-studied non-vented tanks concept is especially superior for liquid hydrogen when sub-cooling is used**

DESIGN PARAMETERS affecting the orbital storage of liquid hydrogen have been established by two National Aeronautics and Space Administration scientists.

J. R. Olivier and W. E. Dempster of the George C. Marshall Space Flight Center, Huntsville, Ala., analyzed the factors involved in storing 40,000 lbs. of liquid hydrogen in a 300-mile geocentric orbit.

Most investigations of on-board vehicle hydrogen conservation are not applicable to orbital storage because of basic heat flux differences. The majority of these studies deal only with vented storage; few give even superficial consideration to non-vented applications.

Preliminary studies established the feasibility of long-term orbital LH<sub>2</sub> storage using a subcooled liquid under non-vented conditions. The NASA experts conclude that non-vented storage has

technical and economic advantages over the vented tank concept.

The thermal environment of an orbiting tank is defined by radiant thermal energy from direct solar sources, the earth albedo and earth infrared.

Direct solar radiation will irradiate the tank outside the earth's shadow. The proper choice of tank surface properties will alleviate this through reflection.

Albedo is solar energy scattered and reflected from earth and earth's atmosphere. Its intensity is about 36% that of direct solar radiation. Albedo has the same wavelength distribution as direct solar radiation; the surface properties needed to reflect the latter will handle the albedo.

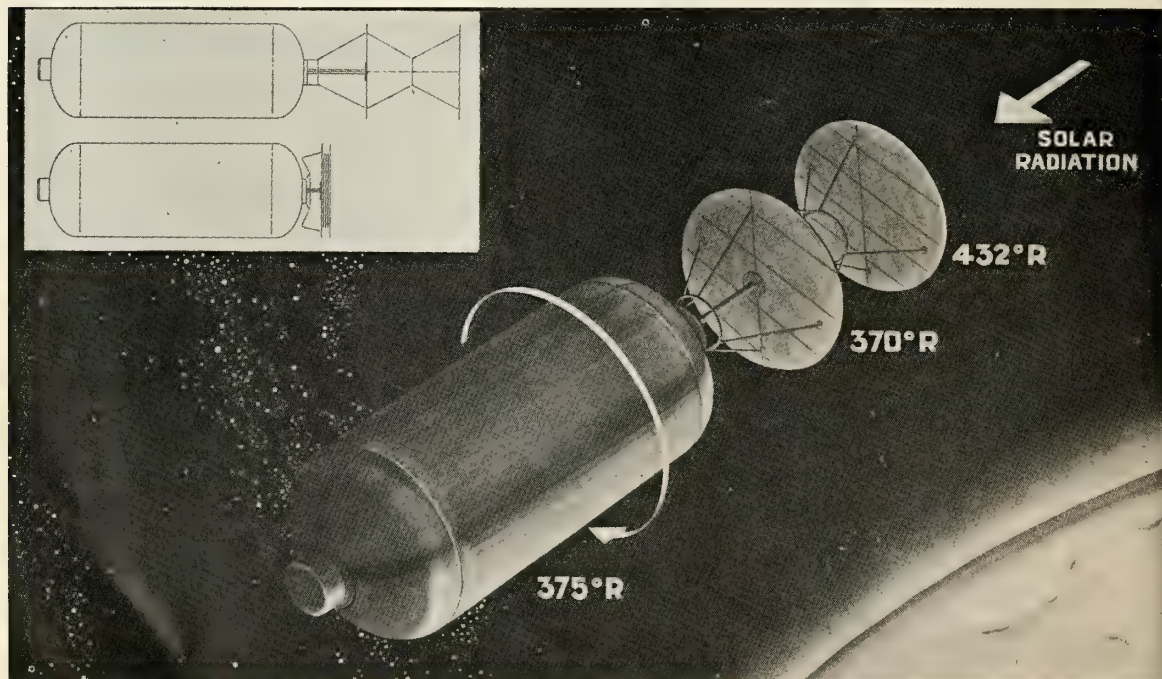
Earth infrared is direct radiation from the earth having approximately 18% the intensity of direct solar radiation. Protection against this type of heat presents some problems because of

its wavelength. Surface properties resulting in low-equilibrium skin temperatures when subjected to solar and albedo are also good absorbers of earth's infrared.

• **Non-vented approach**—Tank configuration was assumed to be cylindrical, although Olivier and Dempster say a spherical chamber is the optimum shape. The cylindrical tank was chosen because the investigation was based on the *Saturn C-2* payload capability.

In addition, superinsulation is assumed, along with negligible effects from aerodynamic heating and initial ullage. Basic storage methods include vented, non-vented and a combination of the two.

Vented or constant-pressure systems are currently the most popular concept of orbital or deep-space storage methods. With such a system, however, a reliable zero-g vent method is necessary



HEAT SHIELDS are most effective if there are no planets in the vicinity and main source of heat flux is solar radiation.

# established

and an additional initial fluid weight is required if a specific quantity is to be available at the end of the storage time.

Olivier and Dempster say that three factors present in orbital storage, but not applicable to ground operations led to the study of non-vented or constant volume storage:

- Propellant cost is no longer dictated by production cost. The pricetag from launch pad to orbit determines the propellant cost. This applies not only to the stored propellant, but also to hardware such as insulation, tanks, and transfer lines.

- The mass of stored propellant does not change with time in non-vented storage. This eliminates the necessity for propellant mass determination at the end of storage, just prior to use.

- Non-vented methods eliminate the need for zero-g venting.

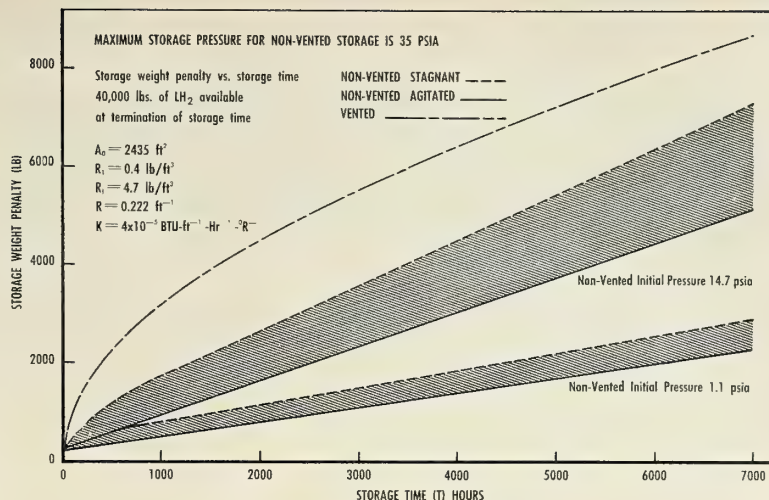
The combined concept could be employed to prevent storage tank rupture if the allowable non-vented storage time is exceeded for any reason.

In comparing the two basic systems, Olivier and Dempster found that the sub-cooled non-vented concept shows a decided advantage over both the vented and normal (not sub-cooled) non-vented methods. A very small weight penalty is involved between stagnant and agitated conditions.

Fluid agitation has a great influence on storage time, but because of the difficulty in predicting the degree of agitation, the NASA experts based all calculations on stagnant conditions—resulting in conservative storage time figures.

The normal non-vented concept has a weight penalty between the vented and sub-cooled non-vented, and exhibits a large difference in weight penalty between the stagnant and agitated conditions.

The vented concept has the highest storage weight penalty for the storage times covered in the study. For extremely long storage periods, the vented curve will eventually cross all of the non-vented lines as graphed. Olivier and Dempster consider this to be of only academic interest, because of extreme



Storage Method Comparison

insulation weight. A trade-off exists where the excess insulation weight exceeds the weight of the on-board refrigeration system.

- **External protection**—Shadow shields were investigated to determine their effectiveness on the overall storage time of a propellant tank in a 300-mile orbit. Such shields are placed between the tank and the source of incoming radiation.

The initial study conducted on shadow shield applications showed Olivier and Dempster that the principle was impractical for bodies in low geocentric orbits. To be efficient, shielding also must be provided against earth albedo and earth's infrared—and this shielding must be continuous.

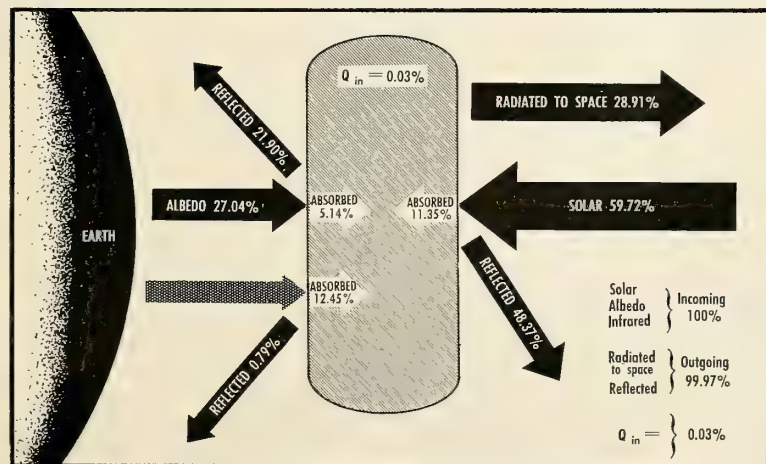
For the shadow case studied, a tank equilibrium skin temperature of 375° R was obtained. This represents only a 45° reduction from the unshielded tank oriented with its axis perpendicular to solar radiation and slowly rotated about

its longitudinal axis.

The lower skin temperature of the shielded tank results in a smaller heat input and thus, a longer storage life—about 5-10% of total storage time. The NASA experts feel that the weight requirements for the shields and orientation mechanism could be more practically traded off by adding more insulation.

Olivier and Dempster conclude that the storage of liquid hydrogen, or any other cryogenic liquid, in a geocentric orbit or beyond in a vented tank is uneconomical and unnecessary. For very short periods, up to two years, the non-vented method will do. For very long storage periods, the LH<sub>2</sub> must be sub-cooled before launch.

In view of this requirement, it is recommended that a study be made of ground support equipment needed for liquid hydrogen subcooling—evaporation, helium-bubbling or refrigeration methods. ❖



Thermal Balance for Orbital Storage



(Continued from Page 15)

vertical position.

The booster will be moved well over a mile to the launch pad, a combination journey on a specially built canal and tracks over which a barge will travel.

• **Cyrogenics Facility**—While it is likely that this building will be used to manufacture liquid hydrogen, oxygen, and nitrogen, no final decision has been made. It is certain, in any case, that such a building will be needed to store the propellants.

Whether it will be used for production will be decided when there is firm information on the rate at which the big boosters will use up the propellants at launch time. Preliminary studies indicate that they will have to be manufactured close by to insure that they are fresh at launch time. \*\*

• **Apollo spacecraft building**—This will be used to assemble and check out the spacecraft, and will be a sharp improvement over current building used to check out the *Mercury* capsule. For one thing, the new building will have proper air conditioning control to insure proper operation of the spacecraft. It will also feature air locks to keep it completely dust-free, excellent humidity control, and sufficient shielding to prevent radiation from seeping in from outside.

• **Nova Control Blockhouse**—This will be built about a half mile from the launch pad. Because the vehicle will be assembled on the pad, no special building is needed.

• **Bio-Medical building**—This will be used to insure "good crew readiness" and also for performance of extensive physical and mental tests on crew members after missions are completed.

Space agency officials admit that quite a bit of dredging and earth filling will have to be done, principally in the launch pad area. They note that contrary to common belief, no major bridges will have to be built.

The large highways running through the Cape will be enlarged to four lanes, and it is expected that another causeway will be built either by local or state officials to connect Canaveral with Orlando.

Officials also said that while basically the present tracking facilities will be used, some beefing up will be needed to provide tracking adequate for Project *Apollo*.

One certain result is that several more Navy ships will be outfitted for NASA tracking and recovery missions. Much more use will also be made of closed-circuit television. \*\*

# AF Says SLAM Would Cost \$500 Million to Flight-test

SOME \$500 MILLION would be required to carry the *SLAM* (supersonic low-altitude missile) program through the flight-test stage—\$400 million of it Air Force money and the remainder from the Atomic Energy Commission.

That cost estimate for the nuclear-powered ramjet vehicle was given to the Joint Committee on Atomic Energy last week by the Air Force.

Col. Ola P. Thorne, asst. deputy chief of staff, research & technology for atomic energy, said the Air Force Fiscal 1962 budget contains \$7 million for *SLAM*, under development at Chance Vought (airframe), Marquardt Corp. (engine), and Lawrence Radiation Laboratory (reactor). Of this amount, he said, Department of Defense has released only \$1½ million to the Air Force. The AEC budget contains some \$30 million for the *Tory* and *Pluto* propulsion test programs leading to *SLAM*.

Chance Vought is known to have put about \$2½ million of its own money into the program.

Dr. Harold Brown, DOD director of research and engineering, told the committee that DOD has not yet formulated plans to utilize the capabilities of such a vehicle. He said an ad hoc committee now is studying the program.

The committee has held one series of meetings during which visits were made to Chance Vought, Marquardt and LRL. Another meeting is set for Sept. 12.

"It is hoped that a final report will be completed by the end of September," Dr. Brown said.

• **Genesis**—He told the committee that as a result of early work with the AEC, starting in 1955, on feasibility of a nuclear ramjet, the Air Force initiated studies with North American, Convair and Chance Vought, amounting to \$200,000 each (M/R, March 28, 1960, p. 14).

"The Air Force made an evaluation of the three proposals and concluded that the most attractive of these proposals was submitted by the Chance Vought Corp.," Dr. Brown reported.

He said Chance Vought then continued with its own funds to develop a detailed study of the problems associated with building and operating a nuclear-powered, ramjet low-altitude bomb delivery system. At the same time, Air Force asked its Systems Command to submit a preliminary development plan delineating the high-risk technical areas.

The Systems Command, noting that the propulsion system was yet to be satisfactorily demonstrated, recommended that any firm commitment on a low-altitude nuclear system be held up pending results of the *Tory II* series of tests.

At about the same time, Dr. Herbert York, then DOD research and engineering director, set up an ad hoc committee under William Littlewood of American Airlines to evaluate the nuclear ramjet. That committee, according to Dr. Brown, came to these conclusions:

1. Since the most critical element in the *SLAM* system is the reactor, adequate reactor performance should be demonstrated in order to resolve the major uncertainty of the program.

2. Development of all elements of the *SLAM* program at that time (October, 1959) would be premature.

3. Current emphasis on *Pluto*, the engine program, seemed adequate.

Dr. Brown reported that in June, 1960, the Air Force Chief of Staff decided that, because of the high-risk technical areas remaining, the program should be oriented toward subsystem development until risks and costs were more clearly defined.

The program has continued along that line during the past year, Dr. Brown said. The AEC has continued with its *Tory* reactor development and testing, with the Air Force funding programs at Chance Vought and Marquardt on ramjet components and the airframe.

Success of the *Tory II A* test in Nevada on May 14 led to further reviews by DOD and the Air Force.

According to Col. Thorne's testimony, the Air Force has suggested to the new ad hoc committee that an additional \$23.4 million is required now to step up the *SLAM* program. He said also that considerably more than this has been requested in the Fiscal 1963 Air Force budget package which has been presented to DOD.

Col. Thorne told the committee that Air Force studies have indicated that nuclear ramjet propulsion is technically feasible.

"However," he said, "we feel that one cannot as yet define a specific system requirement, since the weapon system program risk and probable cost cannot be sufficiently delineated at this time."

He said an expanded program of ground-testing would appear to be logically the next major technical step. \*\*



## Honeywell Adding to Inertial Guidance Plant

MINNEAPOLIS-HONEYWELL has begun construction of an addition to its St. Petersburg, Fla., inertial guidance facility. The \$550,000 addition is being built to meet increased engineering development and production efforts, the company said.

Programs currently under way at the plant include production of inertial guidance systems for *Centaur*, development of the primary and secondary guidance systems for *Dyna-Soar*, production of inertial components for *Polaris*, development of an inertial guidance system for *Saturn*, and a number of classified programs.

**DYNALECTRON CORP.** established a new subsidiary, Data Analysis Corp., with headquarters in Washington, D.C.

President of the new subsidiary is William S. Shoaf, former manager, RCA's Defense Products Div.

The new subsidiary is the firm's latest expansion in the field of automatic data analysis, handling and processing.

**LEESONA MOOS LABORATORIES**, a division of Leesona Corp. is the new name of Patterson Moos Research Div. of Leesona Corp. Leesona's President said "The new name better defines our operations in advanced scientific areas, such as energy conversion at . . . Jamaica, Long Island, as distinct from our R&D work on new textile machinery. . . ."

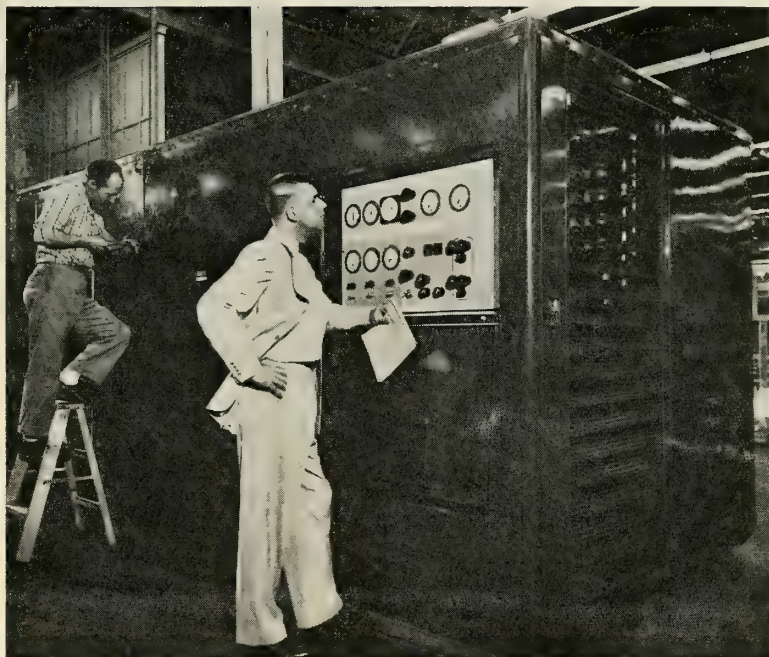
**SYSTRON-DONNER CORP.** has acquired Greenleaf Manufacturing Co., St. Louis, producer of gyroscopes.

Greenleaf will be operated as a division of S-D, which produces electronic instrumentation, computers, transducers and flight control devices for such programs as *Mercury* and *Polaris*.

**GENERAL PRECISION, INC.** Kearfott Div., has established the Kearfott Research Center to expand the company's work in improvement of product lines, and provide information in new product areas. Facilities will be located at West Paterson, N.J.

**AIRTRONICS, INC.** dedicated its new \$1.5-million facility in Bethesda, Md. The plant was specifically designed and built to meet government regulations for handling classified projects.

missiles and rockets, September 4, 1961



## Temperature Control for Titan Fuel

*FINAL CHECKOUT and assembly is made before delivery of the first temperature control unit for Titan II liquid fuel. The units are made by Hamilton Standard Div. of United Aircraft Corp. and will be installed near fuel storage tanks at the missile sites.*

**UNISTRUT PRODUCTS CO.**, Chicago, has established a Clean Room Division to design and build facilities to meet customer requirements and coordinate purchase and installation of all integral equipment and machinery.

**MESA PLASTICS CO.**, Los Angeles, has established a Long Island plant to service the East and Midwest. Mesa produces thermosetting molding compounds. Products range from en-

capsulated resistors, electrical connectors, to missile nose cones.

**POLYMER CORP.**, Reading, Pa., has put in operation a newly remodeled lab designed for plastic product research and pilot plant development. Among the special fluorinated thermoplastic compositions developed by Polymer are a variety with controlled electrical properties for anti-collision devices and special missile applications.

## Financial Reports

| COMPANY                   | PERIOD         | INCOME        |               | EARNINGS   |              |
|---------------------------|----------------|---------------|---------------|------------|--------------|
|                           |                | 1961          | 1960          | 1961       | 1960         |
| Amphenol-Borg Electronics | 6 Mo. June 30  | \$ 34,641,054 | \$ 35,225,005 | \$ 463,470 | \$ 1,532,948 |
| Atlantic Research Corp.   | 6 Mo. June 30  | 9,039,071     | 5,985,215     | 606,035    |              |
| Coleman Engineering Co.   | year, April 30 | 4,577,543     | 4,805,692     | 133,199    | — 552,427    |
| Control Data Corp.        | year, June 30  | 19,783,745    | 9,665,290     | 842,524    | 551,686      |
| Ling-Temco Electronics    | 6 Mo. June 30  | 70,847,881    | 76,120,306    | 827,379    | 1,437,076    |
| Parker-Hannifin Corp.     | year, June 30  | 50,902,464    | 50,711,631    | 2,797,183  | 2,873,537    |
| Sperry Rand Corp.         | 3 Mo. June 30  | 265,823,716   | 291,761,602   | 4,296,313  | 5,410,579    |
| U.S. Industries           | 6 Mo. June 30  | 44,647,000    | 51,026,000    | 1,176,000  | 3,000        |





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# contracts

## NASA

\$250,000—Blaw Knox Equipment Div., Blaw Knox Co., Pittsburgh, for a second-phase feasibility study concerning a 240-ft.-diameter space tracking antenna.

## DOD

\$92,330—Geophysics Corp. of America, Bedford, Mass., for a theoretical study of debris motion following high-altitude nuclear explosions.

## MISCELLANEOUS

\$300,000—Telecomputing Corp., Los Angeles, from Autonetics Div., North American Aviation and Nortronics Div., Northrop Corp., for Minuteman and Skybolt cooling systems.

\$60,000—Epsco Instruments, Div. of Epsco, Inc., Cambridge, Mass., from GE's Missile and Space Vehicle Dept., for a militarized, four-decimal-digit, analog-to-digital converter for use as part of ground support equipment in Project Advent.

## NAVY

\$185,000—American Machine and Foundry Co., Greenwich, Conn., for development of an advanced mobile photographic tracking mount system.

\$110,000—The Boeing Co., Wichita, Kan., from ONR, for a study of physiological reactions to varying degree of vibration.

## ARMY

\$1,400,000—Bendix Corp., Bendix Systems Div., Ann Arbor, Mich., for a communication package for Advent program.

\$1,200,000—Adler Electronics, New Rochelle, N.Y., for production of three AN/TSC-18 air-transportable communications systems.

\$180,000—Electronic Defense Laboratories, Sylvania Electric Products, Inc., Mount View, Calif., for study and analysis of specific electronic warfare techniques. General Electric's Tube Dept., Owensboro, Ky., for designing and determining the feasibility of producing a tube-cavity combination to serve as an X-band local oscillator. No amount disclosed.

## AIR FORCE

\$10,576,765—Chrysler Corp., Detroit, for installation and checkout of the Jupiter IRBM.

\$1,577,102—Hughes Aircraft Co., Culver City, Calif., for GAR-4A Falcon missiles, shipping and storage cases, and empty warhead cases.

\$1,500,000—The Martin Co., Baltimore, for production of TGA-83, trainer model of Bullpup missile.

\$1,096,700—The Martin Co., Baltimore, for storage and distribution of tactical missile weapons system (Mace and Matador).

\$957,940—Melpar, Inc., Falls Church, Va., for seven GAM 83 A/B missile trainers.

\$900,000—Northrop Corp.'s Nortronics Div., Anaheim, Calif., from The Boeing Co., for penetration rocket launchers for use on SAC's B-52H ballistic missile bombers.

\$758,929—Defense Products Div., Fairchild Camera and Instrument Corp., Syosset, N.Y., for new projection viewers for the screening of high-resolution photography.

\$500,000—The Johns Hopkins University, Baltimore, for research directed toward high-altitude astronomical observations.

\$300,786—General Atomics Corp., Bala-Cynwyd, Pa., from Ballistic Systems Div., USAF, Los Angeles, for a theoretical and experimental program to establish the feasibility of an advanced technique for detection of objects in space.

\$225,000—Microdot, Inc., Pasadena, Calif., from Philco's Western Development Labs, for UHF narrow-band data link transmitters and subassemblies for Midas missile alarm satellites.

\$40,671—Aerogel-General Corp., Azusa, Calif., for services necessary to an Aerobee attitude control system gas-dispersion investigation.

## ARPA R&D

Advanced Research Projects Agency, The Pentagon, Washington 25, D. C.

Research and Development Sources Sought.

Major Research and Development Projects currently assigned to the Advanced Research Projects Agency (ARPA) include the following:

Advanced Ballistic Missile Defense-Project Defender. The purpose of this project is to increase technical knowledge in the appropriate scientific fields and techniques which are necessary to establish a technical formulation for the development of advanced defenses against exo-atmospheric offensive vehicles including space vehicles and ballistic missiles. The Defender Project is subdivided in four major areas: (1) General Research which includes missiles physics research, nuclear effects research, atomic and molecular physics research, radio frequency research and research pertaining to charged particle beams; (2) Techniques and Devices which include sensors, over-the-horizon detection, interception and kill mechanisms; (3) Missile Phenomenology, concerned with developing a thorough understanding of the phenomena which occur throughout ballistic missile flight from launch through re-entry; (4) Systems Area pertains to investigations conducted to establish feasible approaches which can provide an acceptable level of ballistic missile and space vehicle defenses at reasonable cost.

Nuclear Test Detection-Project Vela. The Vela Project consists of programs of research, experimentation and systems development for improving the detection of nuclear explosions both underground and at high altitude. It is subdivided into three major programs: (1) Vela-uniform program is involved with improvements in seismological and other geophysical techniques for detecting underground tests; (2) Vela-Sierra program is concerned with techniques for the detection and identification of high-altitude detonations by means of equipment located on the earth's surface; (3) Vela-hotel program includes development of surveillance equipment installed on space vehicles for detecting nuclear detonations above the sensible atmosphere.

Basic Research in Materials-Project Pontus. This project involves research, experimentation, and development to obtain major improvement in materials required to meet the needs of the surface, air, or missile programs. Programs include metallurgy, ceramics, solid-state physics, inorganic chemistry, polymer science and phenomenological studies of materials behavior.

Advance Propellant Chemistry-Project Principia. Research leading to solid, liquid, and hybrid propellants having specific impulses appreciably higher than those now available. Research includes thermodynamics and thermo-chemistry, synthetic chemistry and propellant formulation and evaluation.

Toxicology Research-Project Tores. A research project to acquire basic knowledge of the health hazards of new non-tactical chemical products to insure safe, efficient, and economical handling. These are primarily utilized in new fuels, propellants, coatings, solvents, explosives and lubricants.

Advanced Energy Conversion-Project Lorraine. An advanced research program involving the fundamental aspects of energy conversion in the following categories: thermionics, thermoelectrics, electro-chemistry, magnetohydrodynamics and ancillary studies.

Booklets describing these and other projects in greater detail, and outlining procedures for submitting proposals, may be obtained from the Advanced Research Projects Agency, The Pentagon, Washington 25, D. C.

example...

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FIBERITE 2630A formulation of graphite reinforced phenolic... 30% char depth.



Standard graphite reinforced phenolic 100% char depth.



The development of special Fiberite MX 2630A formulations reduce char depth of graphite reinforced phenolic molded insulations up to 70%, thus permitting the use of these materials in more critical solid propellant rocket motors.

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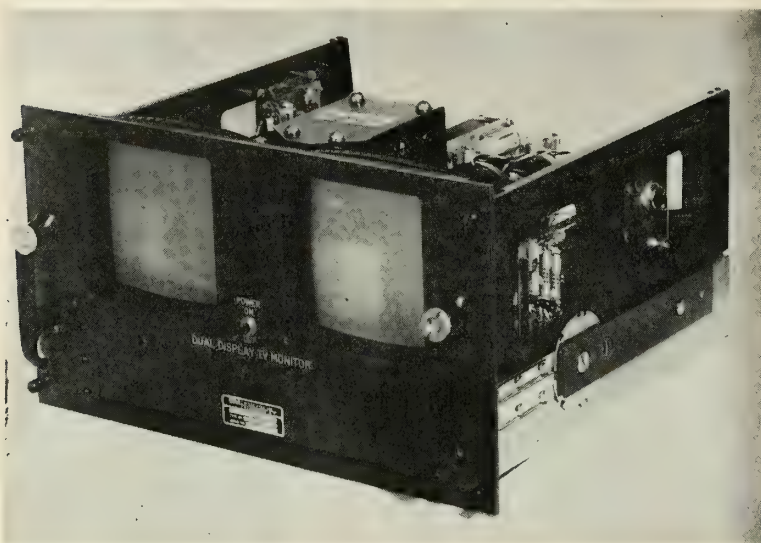


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Winona, Minnesota





## Dual-Display TV Monitor

Two fully transistorized MIL Spec TV monitors on a single 10½-in.-high rack-mounted chassis are being marketed by RMS Associates, Inc. The dual-display TV monitor, Type M20002, feature two 5½ in. x 5½ in. presentations. Conventional 3:4 aspect ratios are also available. Two independent 5.5 mc

video amplifiers and two independent horizontal deflection amplifiers are used. The vertical deflection amplifier is common for both monitors. The unit is especially suited for installation in ground or air-transportable monitoring stations where ruggedness and reliability are important.

Circle No. 225 on Subscriber Service Card

## Intensity Meter

Empire Devices, Inc. is marketing a tuning unit which extends the range of the widely-accepted Noise and Field Intensity Meter, Model NF-105, downward to 14 kc, thus providing continuous coverage from 14 kc to 1000 mc. Designated Model T-X/NF-105, this tuning unit is compatible with all existing NF-105 basic units. Tuning from

14 kc to 150 kc is provided in three ranges: 14-25 kc, 25-62 kc, and 62-150 kc; nominal bandwidth is 1 kc and full-scale sensitivity of 0.1 microvolts. Available as accessory items are a 36-in.-diameter loop antenna, a 41-in. vertical antenna, a line probe and a carrying case.

Circle No. 226 on Subscriber Service Card

## Waveguide Ferrite Isolator

Three compact waveguide isolators are available from the Motorola Solid State Electronics Department for use at J-Band (5.80—8.200 kmc), X<sub>N</sub> Band (8.200—12.400 kmc) and X<sub>L</sub> Band (7.050—10.000 kmc). These devices are transverse-field, resonance-absorption isolators, each designed to maximize load isolation, maintain low insertion loss, and hold VSWR to a low level. Designated Models J103, X103, and XL102, respectively, the J-Band, X<sub>N</sub>-Band, and X<sub>L</sub>-Band isolators exhibit typical performance characteristics of 30 db minimum isolation, 1.0 db insertion loss, and 1.15 maximum VSWR over the specified operating frequency band.

Circle No. 227 on Subscriber Service Card

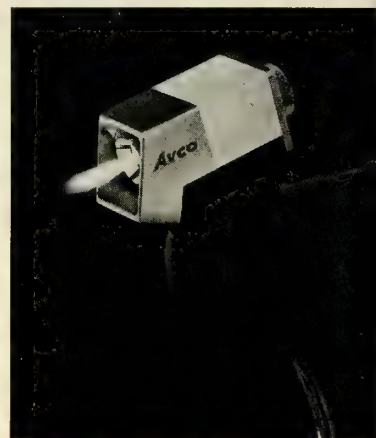
## Microwave Swept Oscillator

Sperry Microwave Electronics Co. is marketing Microline (TM) Model 64 1 microwave swept oscillator series. The sweep may be from low to high, or high to low frequency, and the end points are independently adjustable over the entire frequency range. Sweep rates are continuously variable in four ranges from 0.01 to 100 sec. There is provision for external sweep and d-c coupling to permit frequency programming.

Circle No. 228 on Subscriber Service Card

## IR Pyrometer

A compact infrared industrial pyrometer (no larger than a hand movie camera) is available from the Servo Corp. of America. The pyrometer is designed to cover the industrial infrared wave-length spectrum of from 1-12 microns. Because of its high sensitivity



and fast response, the pyrometer can measure and control the temperature of an object of any size, whether the target is stationary or moving at various speeds. Its sensitive infrared eye watches the target from a remote position, providing complete safety for personnel.

Circle No. 229 on Subscriber Service Card

## Germanium Epitaxial Mesas

A series of six germanium epitaxial mesa transistors, claimed to supplant virtually all germanium mesas, micro-alloy and other transistor types currently used for high-speed switching applications, has been announced by Motorola Semiconductor Products Inc. The units combine greatly improved switching characteristics with drastically reduced prices, and replace transistor types currently in use. Housed in the

missiles and rockets, September 4, 1961





TO-18 package, the units are designed with optimized physical geometry for high-speed switching applications in both high- and low-current circuits, eliminating the need for different transistor types in systems encompassing various design configurations and permitting greater standardization of components and smaller inventories.

Circle No. 230 on Subscriber Service Card

## Microwave Pulse Generator

A MPG-3 microwave pulse generator producing nanosecond pulses at gigacycle frequencies from conventional radio frequency signal generators is available from the Hallicrafters Co. The MPG-3 can also serve as a self-contained wideband traveling-wave-tube amplifier or as a serrodyne amplifier for frequency translation. The MPG-3 is available in six bands—UHF, L, S, C, X and KU—covering the microwave spectrum from 0.5 to 18 gc/s. Both pulse widths and pulse repetition rates can be precisely adjusted. Pulse widths range from 0.03 to 500 microseconds and pulse repetition rates can be varied from 2 to 50,000 pulses per second. Power output is 10 milliwatts.

Circle No. 231 on Subscriber Service Card

## Conductive Plastic

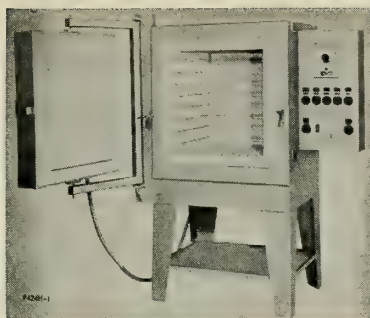
A plastic material developed by Mesa Plastics Co. has very nearly ideal conductive properties in direct contradistinction to the normal conception of plastic materials. A 3-volt bulb, powered by two 1.5-volt batteries wired in series with a probe and a bar of the plastic material, will light no matter where the probe is applied to the bar. Applications include waveguide, RF connectors and electronic components. Pilot uses of the material have found it particularly well adapted to the production of printed circuits where a flush surface is desired.

Circle No. 232 on Subscriber Service Card

## Temperature Sensor

An immersion-type resistance temperature sensor with a 0.2 second time constant has been introduced by Rosemount Engineering Co. The sensing element of the eREC Model 176 is protected by a stainless steel well. Temperature range covered is from  $-435^{\circ}\text{F}$  to  $500^{\circ}\text{F}$ . The fast response for a temperature sensor of this type is achieved by a unique design in which a strain-free element is mounted directly on the inner wall of the well. The Model 176 was designed for storable fuel applications in the missile field, but is suitable for use in any part of the stated temperature range and in any fluid compatible with the stainless-steel material of the well.

Circle No. 233 on Subscriber Service Card



## High Temperature Furnace

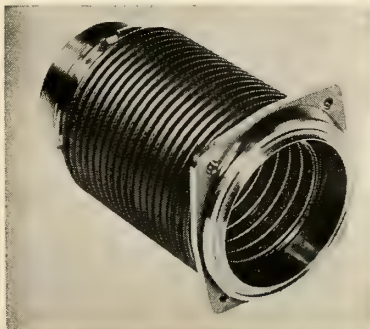
The L & L Manufacturing Co. has produced a small, compact furnace which heats up to  $2000^{\circ}\text{F}$  in one hour;  $2300^{\circ}\text{F}$  in one and a half hours. A constant level of temperature and infinite heat-rate control ranging from  $300^{\circ}\text{F}$  to  $2300^{\circ}\text{F}$  can be maintained by means of input controllers. These can be set at from 7% to 100% of input. Zone gradient control operates by multiple circuits, with each circuit having its own input controller. Gradients are indicated by a pyrometer and two thermocouples, located zonewise, and a thermocouple selector switch. Fully automatic temperature controlled units are also available. Each unit can be equipped with forced convection fans to assure an automatic and even gradient in the furnace at any point along the heat curve.

Circle No. 234 on Subscriber Service Card

## Metal Bellows

Metal bellows and bellows assemblies, supported and unsupported, made by advanced methods to achieve dependability under critical operating conditions, are available from Avica Corp. Bellows are individually designed for use as pressure seals, flexible joints or vibration dampeners in gas or liquid transmission lines subject to high pressure or vacuum and temperature extremes. Available in sizes from 1 in. to 12 in. ID, the bellows are made in stainless steel and other metals in either developmental or production quantities.

Circle No. 235 on Subscriber Service Card



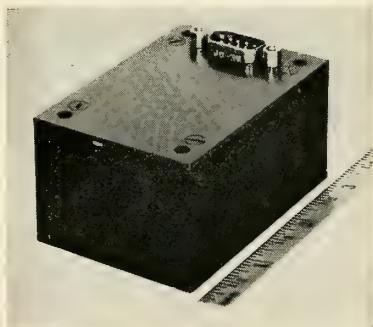
## Electrohydraulic Actuator

The Annin Co. is marketing a 20,000 Series electrohydraulic actuator which offers extremely fast speed, high frequency response, good positional accuracy and large thrust. Custom-designed for specific applications, the actuator, designated Model EHA-1, provides a means of converting a suitable electrical signal from an automatic or manual electrical control station to a powerful hydraulic force. The actuator is responsive to minute rapid changes in electrical signals and delivers instantaneous action while remaining inherently stable under adverse operating conditions.

Circle No. 236 on Subscriber Service Card

## D-C Amplifier

International Data Systems has developed a silicon transistor chopper d-c amplifier with differential isolated input. All circuits, including the chopper and synchronous demodulator, utilize silicon transistors in order to allow operation from  $-20^{\circ}$  to  $100^{\circ}\text{C}$  and also to withstand missile environment with respect to shock and vibration. Full-scale input voltage is  $\pm 10$  mv (maximum gain) to



$+250$  mv (minimum gain). Full-scale output signal is  $\pm 5$  v and is completely balanced and isolated from ground. Frequency response is 0 to 3 kc. Stability is  $\pm 2\%$  of full scale, with linearity of 1% of full scale. Gain is continuously adjustable from 20 to 500.

Circle No. 237 on Subscriber Service Card

## Hydraulic Load Simulator

A 10-channel hydraulic load simulator, capable of accurately delivering up to 500,000 lbs. per channel, is available from Gilmore Industries, Inc. The simulator control console contains all the measuring and control components for 10 independent channels of hydraulic force control. Each channel uses a load cell transducer coupled to a hydraulic cylinder. A force on any cell will cause an unbalance of the strain-gage bridge within the cell, resulting in a voltage signal proportional to the force. The



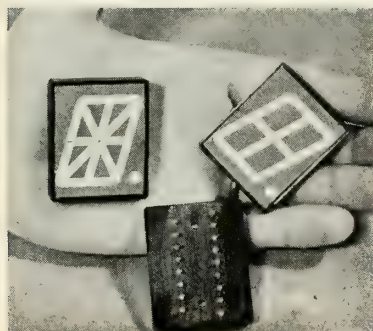
## ...products and processes

control console receives this signal and compares it with a "command" signal controlled by the operator. Any difference in signal is detected by the servo amplifier, and a correction signal is sent to the four-way servo valve which will vary the hydraulic pressure at the cylinder.

Circle No. 238 on Subscriber Service Card

### Read-Out Panels

Reliable electroluminescent panels for the display of numeric and alphanumeric information have been developed by Sylvania Electric Products Inc. The 1½-in. panels, designated AN-150 and NU-150, are composed of segments of electroluminescent lamps insulated from one another and individually terminated. Type AN-150 has 14 segments that produce the complete alphabet, 0-to-9 numerics, a decimal point, and other mathematical symbols. Type NU-150 consists of nine segments which produce a display of 0-to-9 numerics, a decimal point, and selected mathematical symbols. Below the panel



is a rear view of the base used on both devices. The basic design and structural simplicity of the display devices and panels offer the advantages of minimal catastrophic failure, high reliability, long life, simplified circuitry, negligible power requirements and compactness.

Circle No. 239 on Subscriber Service Card

### Coaxial Mechanical Switch

E&M Laboratories has available a microwave coaxial mechanical switch. The switch has been designed to withstand the extreme environments of modern missiles. Ruggedness for durability against shock and vibration, and capability to operate in temperatures up to 300°F, have been combined with minimal size. Standard units cover the frequency range of 0 to 6 kmc, and switch in a nominal operating time of 10 milliseconds. The actuator requires approximately 8 watts of power.

Circle No. 240 on Subscriber Service Card



### Cryogenic Valves

Hardened seats for longer life are featured in the new Hydraulic Research miniature cryogenic valves designed for missile applications. The valves—production items—range from 100 psi to 4000 psi in capacity, and operate dependably in a temperature range from -425°F to 300°F, according to the manufacturer, with an extremely low degree of internal leakage. Functional tests using 1000 actuations at various temperatures showed zero leakage in the 70°F range with leakage as low as 0.5cc at -300°F at 3000 psi.

Circle No. 241 on Subscriber Service Card

### Scratch Gage

Bausch & Lomb is marketing a scratch-depth gage which measures scratches, grooves and other indentations on flat or curved surfaces with high speed and accuracy. Because of its ease of operation and portability, the new gage provides a precise, inexpensive and non-destructive means for determining whether such surface indentations fall within prescribed limitations. It works equally well for measuring raised portions of workpieces. Highly precise measurements to an accuracy of ±0.0001 in. or 5% of the depth, whichever is greater, can be made for indentations with depth of from 0.0002 to 0.016 in.; widths from 0.001 to 0.050 in. can be determined to ±0.001 in. The same range applies to the measurement of raised portions. In addition to depth and width measurements, the gage clearly shows the contour of the indentation.

Circle No. 242 on Subscriber Service Card

### Photoelectric Modulators

A low-impedance line of Photoelectric Modulators or "Choppers" has been developed by Cambridge Electronics Corp. These units, designated M10L

and M20L, are designed to match circuit impedances of 1.5 K-ohms, and offer either SPST or DPST switching action, respectively. Being non-mechanical in nature, they are not hampered by contact wear or non-ohmic conduction effects, and create no vibration in other circuit elements. Carrier feed-through is less than 1 uv. Operating life exceeds 5000 hours. Modulation frequencies up to 1 KC are possible.

Circle No. 243 on Subscriber Service Card

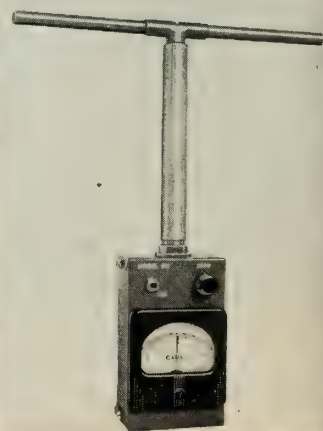
### Pulse Amplitude Shaper

Franklin Systems, Inc. has designed and produced a pulse amplitude discriminator and pulse shaper whose input is suitable for operation from pulse amplifier and special pulse circuits. The output is utilized for analog integrating circuits (with meter or recorder) as well as digital counters and oscilloscopes. This completely transistorized plug-in unit will fit in the palm of a hand.

Circle No. 244 on Subscriber Service Card

### Magnetic Field Detector

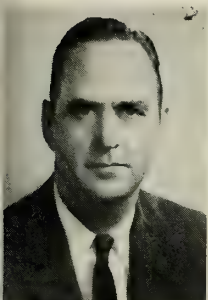
A sensitive detector, Model 501, capable of measuring d-c magnetic fields as low as one-quarter gauss, has been announced by the Halltest Division,



Instrument Systems Corp. The instrument may be used in the measurement of the earth's magnetic field, fields in the vicinity of scientific installations, determination of strength and orientation of magnetism in critical ship and aircraft structures. Based on the Hall-Effect principle and utilizing high-gain Siemens Hall generators, the unit operates without amplifiers and provides a center-to-full-scale deflection of 0 to 5 gauss. Compactness achieved through simplified design and power requirement of only one mercury cell permits the instrument to be held with one hand. Size is 5¼ in. x 3 in. x 3 in.

Circle No. 245 on Subscriber Service Card

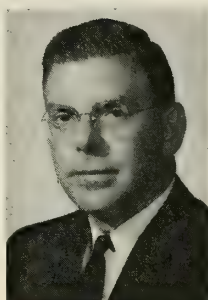
# names in the news



BLAIR



CLARK



BINGHAM



ROMIG



CHILTON

**Dr. Finn J. Larsen:** Appointed Assistant Secretary of the Army for Research and Development. Dr. Larsen previously was associated with Minneapolis-Honeywell Regulator Co. as vice president in charge of research, and from July 1961, has served as consultant for Research and Development to the Secretary of the Army.

**Evan Noonan:** Chief of the Propellant Division for the Chemistry and Explosives Research Dept., White Oak Naval Ordnance Laboratory, died August 23 of a heart attack. With the Laboratory since 1949, Noonan was an authority on rocket fuels, helping to coordinate interservice developments in this field and to judge the efficiency of systems already in use.

**James H. Douglas:** Chicago attorney and former Deputy Secretary of Defense, elected a trustee of The MITRE Corp., Bedford, Mass. **Edward Reynolds, Jr.,** elected treasurer of MITRE, filling the vacancy caused by the resignation of **J. J. Snyder.** Reynolds formerly was assistant to the vice president and head of the contract administration department, Canadian Pratt & Whitney, a subsidiary of United Aircraft Corp.

**Claude M. Blair:** With American Telephone & Telegraph Co. over 30 years, elected vice president with responsibility for the company's satellite communications programs.

**Frank D. Banta:** Elected assistant vice president and an officer of General Precision, Inc., Tarrytown, N.Y. Banta will continue to serve as director of program management.

**V. G. Nielsen:** Retired Thompson Ramo Wooldridge Corp. vice president and consultant on the formation of Aerospace Corporation, elected to the board of trustees of Aerospace. **Allen F. Donovan,** senior vice president, technical, of Aerospace Corp., elected to the board of trustees.

**Carey Carpenter:** Elected executive vice president, Copolymer Corp., Los Angeles. Active in reinforced plastics since

1953, Copolymer will broaden its research and development effort under the former technical manager of Swedlow, Inc.

**Paul Gottfried:** Joins Booz, Allen Applied Research, Inc., Washington, D.C., as a reliability scientist. Prior to joining BAARINC, Gottfried was a partner in Reliability Engineering Associates, Chicago.

**Dr. Neal Zierler:** A noted authority on coding theory, joins Arcon Corp., Lexington, Mass. **Dr. Robert W. Sittler,** well-known for his work in sampled data systems analysis and feedback control systems analysis, appointed technical director of Arcon.

**Dr. Bernard R. Linden:** Promoted to director, Electron Tube Branch, CBS Laboratories, Stamford, Conn.

**R. Adm. John E. Clark, USN:** Former Commander, Carrier Division 16, Atlantic Fleet, assumes command of the Pacific Missile Range. Adm. Clark relieves R. Adm. Jack P. Monroe, USN, assigned to a newly-established billet as director of Development Facilities in the Office of Chief of Naval Operations, Washington.

**Lt. Col. Lee B. Ledford, Jr. (USARet.):** Appointed assistant to the president, Kollsman Instrument Corp., a subsidiary of Standard Kollsman Industries, Inc., New York City. Until recently, Col. Ledford served as chairman of the Board of Review, Dept. of the Army.

**Robert W. Bingham:** Named program manager of Fairchild Stratons Corp's new XE-2 multi-purpose drone project. Previously Bingham has held technical and managerial positions with Western Electric, Aberdeen Proving Ground, Army Chemical Center and U.S. Biological Laboratories.

**Dr. Kenneth L. Miller:** Appointed head of Applied Mathematics Section, Mathematical Analysis Dept., Computation and Data Reduction Center, Space Technology Laboratories, Inc., Los Angeles. **Jerome M. Schwarzbach** named manager, Systems Engineering Dept., **John T. Blake,** special technical staff assistant, both in Atlas program office of STL.

**Dr. Harry G. Romig:** Previously senior scientist and staff member of Operations Research, Inc., named corporate director of quality engineering, Leach Corp., Los Angeles, with primary emphasis on Relay Division activities.

**Robert C. Chilton:** Former vice president-development planning, Horky-Moore Associates, a division of Houston Fearless Corp., joins Space Equipment Corp., Los Angeles, as secretary and contracts administrator.

**Donald E. Boren:** Promoted to manager, Data Acquisition Planning, Pan American's Guided Missiles Range Division, Patrick AFB, Fla. **John Park** named manager, Data Support Planning.

**George Friedl, Jr.:** Former vice president and director of operations, Westwood Division, Houston Fearless Corp., elected chairman of the board and chief executive officer, The Matthews Corp., Hawthorne, Calif. Friedl succeeds **Walter H. Girdler, Jr.** who died August 10.

**Rudolph Furrer:** Joins Lockheed Missiles and Space Co., Sunnyvale, Calif., as special assistant-reliability. Furrer formerly was special assistant to the Director of Defense Research and Engineering for Engineering and Reliability.

**J. J. Seidman and C. R. Russell:** Named manager and associate manager, respectively, of the Computer Dept., Electronics Div., Space Technology Laboratories, Inc., Los Angeles. **George A. Harter** named study director in the Electronics Div., STL, Los Angeles; **Eldon J. Seagrist,** manager of STL office, Arnold Center, Arnold Air Force Station, Tullahoma, Tenn.

**D. J. Harnett:** Named vice president and counsel, United Industrial Corp., Los Angeles. Formerly Harnett was assistant general counsel at Telecomputing Corp.

**Arnold Pollack:** Former head of environmental test and design at Airborne Instruments Laboratory, appointed general manager, Aerotest Laboratories, Inc., Deer Park, L.I., N.Y.



## Blimps for Mercury

To the Editor:

Let me congratulate you on your excellent article, "Mercury Rescue: Mission for Blimps," by William E. Howard (M/R, Aug. 7, page 17). It is eminently sound in substance and well phrased, on a subject of high national importance.

T. G. W. Settle  
Vice Admiral, U.S. Navy, Ret.  
Washington, D. C.

## Finds Us Helpful

To the Editor:

Congratulations on putting out such a splendid rundown on missiles and rockets, especially in the Fifth Annual World Missile/Space Encyclopedia (M/R, July 17).

As a newswriter (Civil Service title, not mine) for this command, which is steadily getting into the Space Age scheme of things, I find your magazine invaluable. We call it the "Space Age Bible" hereabouts.

As a father of seven, many teenagers among them, it would seem to me that your magazine would be a boon to many high schools and colleges, not to mention the military service schools, etc.

I am a retired Navy chief (30 years) working for the Air Force, writing much Space Age copy. Until I discovered M/R, much of this writing was a chore. Now it's a pleasure, thanks to you and your staff, which puts out such good dope.

Mike Lynch  
Information Office  
Hqs Sacramento Air Materiel Area  
McClellan AFB, Calif.

## Hungry for Facts

To the Editor:

Apologizing for intruding upon you, I beg to inform you as follows:

My name is Fabio M. Berto, and I am 20 years old. About five years ago, I was forced to discontinue my regular course of studies and take up a job, owing to my family's economic circumstances. But, because my love for studying is very great, I employed all my free time perusing my books on mathematics, physics, chemistry and astronautics, with the help of my father, Mr. Luigi R. Berto, who in his time attended schools of the highest order and had been an astronautics pioneer in Europe—taking up as early as 1929 the study of space flight. . . .

About three years ago, the economic situation of my family had improved, making it possible for my father and me to devote more money and time to astronautics.

In August, 1958, my father delivered a lecture on Italian television, presenting models of rockets as well as photographs of space. In November, 1959, the Astronautics Sciences and Space Technology Diffusion Center was founded, with my father as President and I as General Sec-

retary. In June, 1960, the Diffusion Center started a free correspondence course, the first and unique of its kind in the world, dealing with all problems related to space travel. The number of memberships is now impressive.

Furthermore, my father devoted much of his leisure time to writing articles and stories for newspapers, books and magazines, while I planned and launched many solid-propellant rockets, attaining in March last an altitude of about three-thousand meters.

Since ours is a non-commercial, non-profit organization, it is poorly equipped and lacks the means for actively promoting the development of an astronautical consciousness in Europe.

Hence, I take the opportunity to address this letter to you to ask for material or moral help, which as you know is very difficult to obtain here in Europe. I should be much obliged if you can tell me where I can address questions about U.S. astronautical developments, because the United States Information Services (USIS) has long been without such information.

In fact, in May, 1960, under the auspices of the Italian Consul General, Dr. Guido Zecchin, we delivered a series of astronautical lectures in Yugoslavia on which we received the warmest congratulations. But the USIS in Trieste was unable to supply photos, films or fact-sheets on astronautical subjects, and we found it necessary to show *American developments through use of Soviet books and newspapers, as shown in the photocopies attached.*



рис. 97. Американская межконтинентальная баллистическая ракета «Атлас».

SOVIET-PUBLISHED data on Atlas.

In view of the above, I shall be grateful if you will let me know whether you can send us some photographs, data, fact-

sheets, booklets, etc., which we could use in our public lectures or our Correspondence course.

In this way and with these small means we will attempt to make our small contribution to Science and to the cause of the Western World.

Fabio M. Berto  
General Secretary  
Astronautics Sciences and Space  
Technology Diffusion Center  
Trieste

M/R has mailed to Mr. Berto 25 copies of its Fifth Annual World Missile/Space Encyclopedia. We forwarded a copy of his letter to USIA chief Edward R. Murrow.—Ed.

## More Dean Pro & Con

To the Editor:

As a reader of M/R for its scientific information value, I take serious offense at the continuing debacle of the Dean Space Drive in your columns. The original obscure and confusing description of the system (M/R, May 1, p. 24) was followed by the customary crackpot claims, then by clearer but overelaborate disproofs. W. J. Lohninger's letter (M/R, Aug. 7, p. 6) is a return to such garbled rambling that it is unclear whether he is pro or con.

M/R is prejudicing its reputation as a credible source of missile science developments by persisting in reporting such pseudo-scientific claims as Dean's and his proponents'. A clear description of the principle of operation of the "Drive" and its logical disproof are topics on the elementary physics level and unworthy of a prolonged technical treatment.

I suggest abandonment of the topic and relegation of models of the "Drive" to the museum of perpetual motion machines (or to outer space under their own power).

Donald E. Wedekind  
Cape Canaveral

To the Editor:

Since the publication of the article on the Rabinow Report on the Dean Drive (M/R, June 12, p. 24), I have been waiting to see a letter or an article pointing out the discrepancies in the report as presented. Apparently no one else has taken the trouble, so I'll do it myself.

Before I list the discrepancies I want to make one or two things clear:

1. Although I witnessed a demonstration of the Dean Drive over a year ago, the discrepancies I have indicated can be discovered by examination of the patent, the original article on the Drive (M/R, May 1, p. 24) and a good physics text.

2. I have no connection with Dean Systems Inc.

3. Your "Letters" department won't accommodate a detailed rebuttal, nor do I wish to take time at the moment to prepare one. . . .

There are three immediately apparent conflicts:

1. The first thing that caught my eye

when I looked at the article was the oscillogram. The May 1 article stated that the effective drive occurred through an angle of 60 degrees. The illustrations in the patent support this by the shape of the cams (fig. 6) and the choice of six pairs (fig. 11) to illustrate continuous thrust. The oscillogram shows an intense spike with a duration of slightly over 9 degrees (as determined with a ruler) with some positive "noise" extending for about 82 degrees (incidentally, where does that "noise" come from?). Obviously then, the oscillogram shows that the machine was not working at the time, but this does not prove that the machine can't work when it is operating properly.

2. The next thing that caught my eye in the May 24 article was the schematic. The May 1 article, the patent, and the figure on p. 42 of the May 24 article show the solenoid and the fixed springs attached to the fixed frame. The schematic indicates that they are attached to the load arm. If Mr. Rabinow had the machine set up as depicted in the schematic, the results he obtained are not surprising—but again that is not the way the system is designed, so the results don't apply to the Dean Drive.

3. The final item is a bit more subtle. Mr. Rabinow concluded that "The system does not have any unusual properties, nor does it contradict Newtonian laws of mechanics." On the next page he states that the "clutch grasps the load arm when the eccentric weights are on the far side of the load." Now (unless I have forgotten my physics), according to the classical laws of mechanics, when the weights are on the far side of the load, the carriage to which the clutch is attached would be moving in the negative direction—toward the load, not away from it. The fact that any positive force is exerted at that point indicates (to me at least) that Classical Mechanics needs a second look.

At this point I would like to insert some of my own speculations. A hundred years ago there was a Law of Conservation of Matter and a Law of Conservation of Energy—stated separately. The concept that one was a special case of the other would have been brushed off as not worthy of consideration, and it was "obvious" that changing the mass of a system without adding to or subtracting matter from an external system violated the Law of Conservation of Matter. Today there are Laws of Linear Motion and Laws of Rotary Motion separately stated, and it is "obvious" that changing the linear momentum of a system without adding to or subtracting from the linear momentum of an external system violates the Laws of Linear Motion. Could it be that the Dean Drive takes advantage of a hitherto-unnoticed relationship and that linear motion is a special case of rotary motion or that both are special cases of a general curvilinear motion not yet described? Incidentally, isn't the current consensus that space is curved, and that, therefore, there is no such thing as a straight line?

Finally, it is rather ironic that about a year ago M/R published an article on a study of field force propulsion (M/R, July 11, 1960, p. 27) which quoted an en-

gineer to the effect that it "seems possible" to produce rectilinear motion in free space without expelling mass. The article goes on to imply maintenance of a 1-g environment within a vehicle accelerating at 100 g. Strangely enough, there wasn't a single letter of comment in the next five or six issues. Perhaps, because the article mentioned things like unified field theory, quantum mechanics and matter-to-energy conversion, readers were sufficiently awed so that they hesitated to challenge the idea. Apparently, the really shocking thing about the Dean Drive is not that it produces unidirectional motion, but that it is a simple mechanical device that any competent machinist can build with existing techniques and materials. . . .

Douglas P. Price  
Kensington, Md.

## Pride and Prejudice

To the Editor:

Re your Aug. 14 editorial ("Assignment: National Survival"):

The Aircraft Industry still associated with manned aircraft can still *command* pride. However, it is doubtful that the missile/space industry will reach a position deserving pride in the sixties.

Surely your self-admittedly trite comment will go down as outstanding for the decade.

If those of you in the missile/space industry want to do something for the good of the United States of America, how about selling the hardware of the industry

to us at least at cost, as long as it is inferior merchandise?

Richard B. Monroe  
Captain, USAF  
Oxford, Ohio

To the Editor:

Congratulations on the editorial. I especially like the statement, "We have a nation full of people who have been asleep for years."

With respect to the next statement, "Until they wake up, we will continue to run second best to the Russians in this and many other fields," I predict that this will be true for a short time. Then, if no awakening occurs, we will fall further and further back to either being a satellite (non-space type) nation or a radioactive waste.

David W. Johnston  
Washington, D. C.

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# SLAM: Time to Fish or Cut Bait

THE PUBLIC SPOTLIGHT turned on the highly-classified project *SLAM* in open congressional hearing this past week may do much to insure the program against meeting the same fate as the late-lamented aircraft nuclear propulsion program.

*SLAM* (supersonic low-altitude missile) is the nuclear-powered ramjet vehicle under development at Chance Vought, Marquardt Corp., and Lawrence Radiation Laboratory.

Officials of the Department of Defense, Air Force and the Atomic Energy Commission were called before the Joint Committee on Atomic Energy to testify on progress of the program.

Although funding for *SLAM* and its preliminary projects, *Tory* and *Pluto*, is as yet only a fraction of that of the abortive billion-dollar ANP program, committee members quite rightly expressed concern that *SLAM* might be starting down the same road.

The committee warned Dr. Harold Brown, DOD's research and engineering director, to keep a close eye on management of the program to prevent a repetition of the ANP debacle.

There are two schools of thought on what should be done to prevent *SLAM*'s becoming another ANP program:

1. Kill it now without pouring into it the estimated \$500 million it will take to develop a flight-test article.

2. Provide sufficient funds early enough to give the program a healthy growth schedule and carry it through to a successful conclusion.

One of these courses of action should be taken just as promptly as possible. The third alternative—a half-hearted effort on a drawn-out starvation budget—will only repeat the ANP disaster.

There seems little doubt at this point about feasibility of the nuclear-powered ramjet vehicle. Critical element in the *SLAM* system is the reactor, and the success of the *Tory IIA* test in Nevada on May 14 indicated problems in this area are being solved.

"It is possible to make a reactor with the assumed characteristics," Dr. Brown assured the committee.

The big question mark hanging over *SLAM* is whether an operational requirement for it actually exists. The Air Force and DOD attitude toward the program has been lukewarm.

Committee members were somewhat miffed by the fact that, whereas top officials of NASA and AEC were on hand for the previous day's hearing on Project *Rover*, the Air Force sent what the com-

mittee considered its third string to the *SLAM* hearing.

An Air Force witness testified that *SLAM* had been downgraded from priority Category II to Category III. The B-70, by contrast, is Category I. He disclosed that DOD has frozen \$5½ million of the \$7 million set aside in the Fiscal 1962 budget for *SLAM*.

"The Department of Defense has not yet formulated plans to utilize the capabilities of a nuclear-powered ramjet vehicle," Dr. Brown told the committee.

IT ALL ADDED UP to very half-hearted support of the program. Rather than suggesting a go-ahead for a flight-test program, the Air Force proposed expansion of ground testing.

Dr. Brown's report that he had appointed an ad hoc committee to assist him in making his decision about continued development of *SLAM* also failed to impress the committee.

"One of the best ways to kill a program is to set up an ad hoc committee," Rep. Melvin Price (D-Ill.) told him.

The review by the ad hoc committee, which is due to report by the end of the month, is one of a number that have been carried out in regard to *SLAM*. The Air Staff made its own review following the successful *Tory IIA* test. It appears that the program indeed runs the risk of being reviewed to death.

But the ultimate review which may do the program in is that by top DOD brass. It must be decided whether *SLAM* is sufficiently attractive to warrant development as a full weapon system or whether, in fact, the B-70 offers a more attractive way of doing the same thing. A DOD decision against *SLAM* would not meet much opposition from B-70 proponents.

Industry members of the *SLAM* team privately express the opinion that the decision which must be made now is whether to kill the project or proceed immediately to a flight test program. Anything less, they feel, would be unsatisfactory.

We agree. Any compromise decision will only lead to another ANP program. And we think the Congressional committee has performed a worthwhile service in bringing the problem out into the open.

William J. Coughlin



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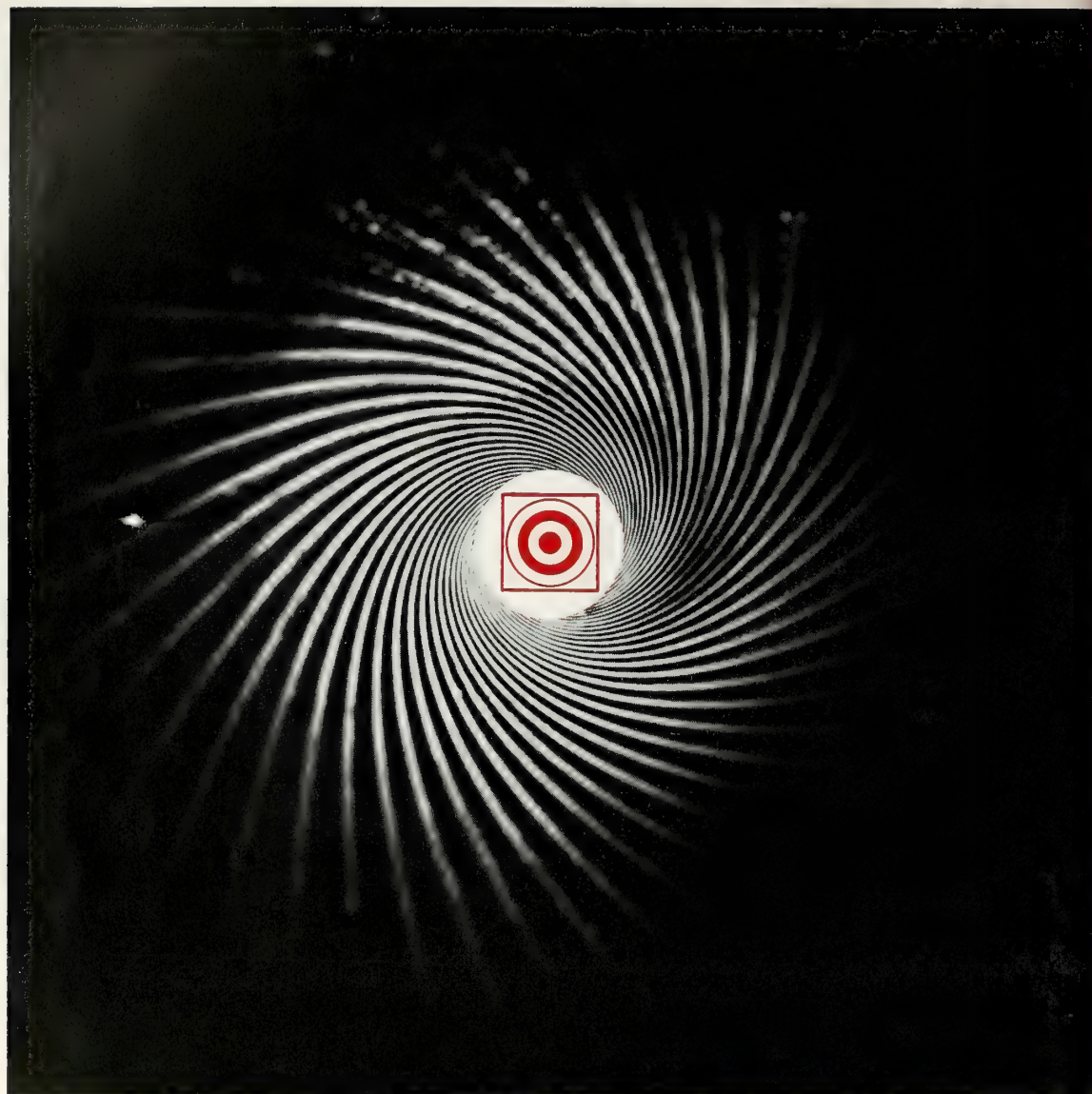
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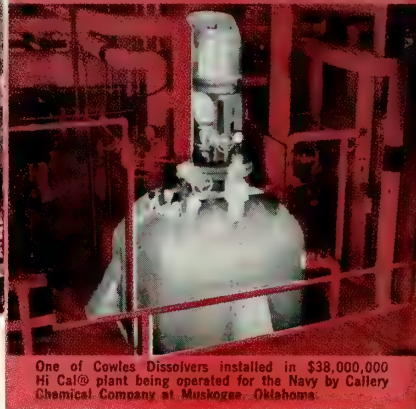
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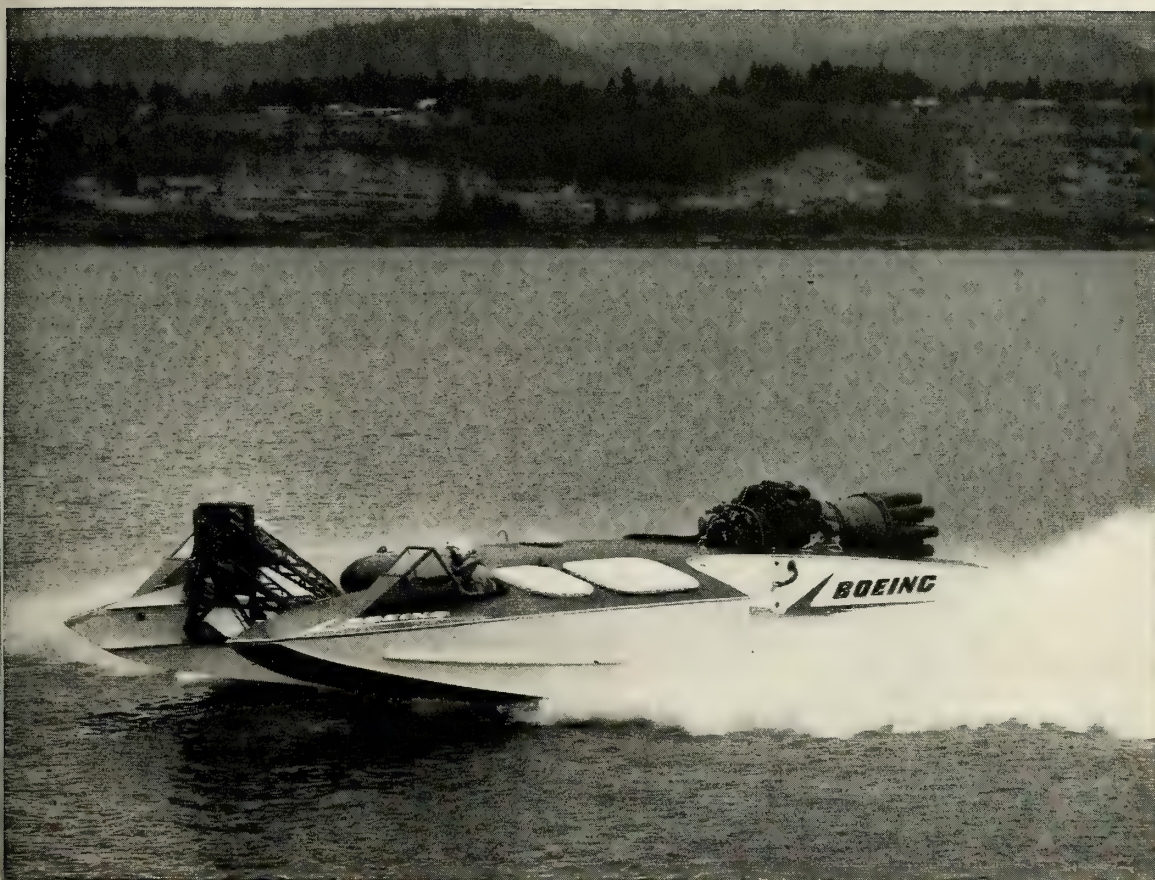


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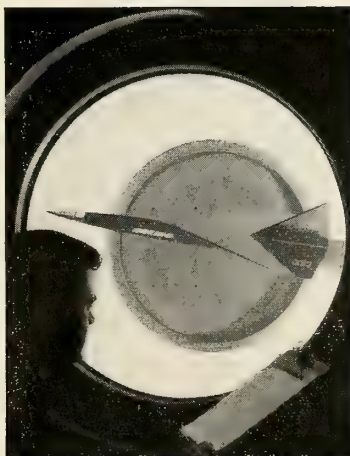
suspended between prows from structure which controls action of model being pushed through water. These hydrodynamic design studies are typical of expanding Boeing efforts in marine field, which include building a hydrofoil patrol craft for U.S. Navy.

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**CARGO-JET.** Boeing C-135 cargo-jet, first of 30 ordered by the Military Air Transport Service, has already been delivered. These 30 C-135s will provide MATS with work capability equivalent to 100 propeller-driven transports.

**SUPERSONIC** transport model being tested in Boeing wind tunnel. Boeing is investing substantial sums in supersonic transport research. Future skyliners would be able to fly from New York to London in less than three hours.



**SPACE GLIDER.** Drawing of Dyna-Soar, U.S. Air Force manned space glider designed to rocket into space, then re-enter earth's atmosphere for conventional pilot-controlled landing. Dyna-Soar is being developed by U.S. Air Force in cooperation with NASA, with Boeing as prime contractor for both the system and the glider.

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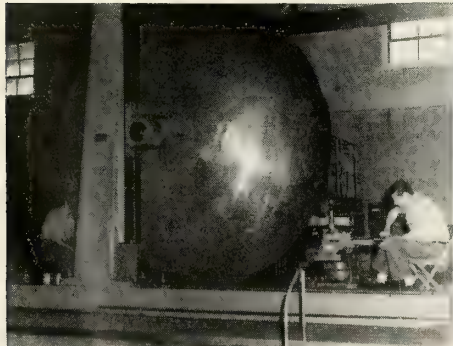
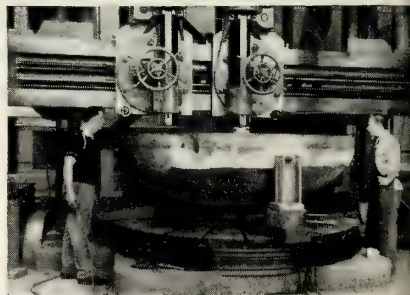


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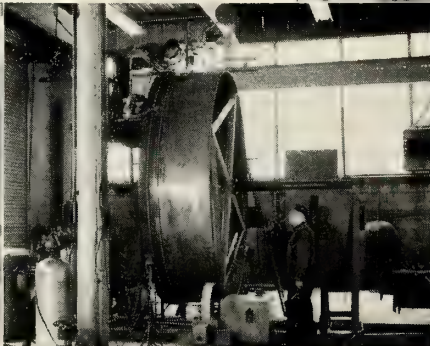
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September 11, 1961

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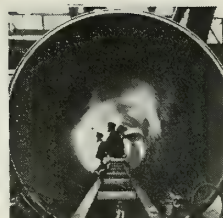
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fective and enclose recent address label if possible.

## THE COVER

*Minuteman first-stage case is minutely in-  
spected with extended carriage arrangement  
at GE's Evendale plant. Company is ready  
to turn out huge solid cases. See p. 24.*



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†U.S. Reg. Pdg.

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## letters

### Apollo Guidance

To the Editor:

As a Program Planner vitally interested in the *Apollo* Program, I would like to call to your attention two items in curious juxtaposition in your Aug. 14 issue. Page 37 ("Prospector Getting Hard Second Look") says that Dr. C. Stark Draper's MIT Instrumentation Laboratory "is the oldest member of the *Apollo* contractor team. The early selection of the guidance-navigation system contractor was required because the guidance system development is basic to the overall *Apollo* mission." This certainly contains a strong implication that the guidance and navigation is one of the critical long-lead items on *Apollo*, an implication the writer agrees to heartily.

Page 38 ("Guidance Adequate for Soft Landing"), however, should banish any such thoughts. It contains the assertion by the popular Dr. Draper "that guidance and control will never be a limiting factor in any future U.S. space effort. When the rest of the technology is ready for another step forward, it will find G&C ready and waiting."

Since G&C is generally interpreted to include guidance and navigation, the minor difference in terminology doesn't help to clarify this paradox.

In any case, the writer welcomes NASA's early placement of the guidance and navigation contract for *Apollo* and suggests that Dr. Draper might have added to his remarks at Stanford "if the go-aheads are early enough."

R. J. Mehling  
Advanced Design Program Planning  
Martin-Baltimore  
Middle River, Md.

In his speech, Dr. Draper was referring in general terms to the state of the art in G&C. Obviously even though the art is relatively well advanced, guidance for a program of the *Apollo* type must be developed early.—Ed.

### Assignment: Survival

To the Editor:

In your excellent Aug. 14 editorial you question: "What can the president of the electronics component firm do?"

Mr. Jerome Taishoff, president of the Mylex Corporation of America, has been deeply aware of the dangers which face the United States and the entire free world. He wanted to do something that would help wake up the country and bring some knowledge of the frightening future that awaits us unless we take effective action.

He had read and been greatly moved by Gen. Alexander P. De Seversky's latest book—"America, Too Young to Die." Of de Seversky's book, one reviewer said the reader opens "scoffing and closes scared." Nevertheless, this reviewer and most of the others recommend that de Seversky's book be read by every thinking American.

Mr. Taishoff felt that if he could make prominent opinion-makers aware of the thesis of the book he would have made a contribution to the awakening of the United States. With this in mind he has sent to date approximately 900 copies of "America, Too Young to Die," personally autographed by the author, to individual whose business interests and affiliations extend into every phase of the avionics/electronics industry, and to others who influence national and industrial thinking.

De Seversky contends, among other things, that the broad industrial electronics base of America is vital in developing a powerful defense against nuclear attack. Further, if properly utilized it will enable us to overtake the USSR in aerospace power and thus protect ourselves, because in this field we unquestionably lead in the art as well as in the techniques of production.

Jerome Taishoff hopes that he is making a contribution to the future of America. He plans to keep right on sending out the book to those who will read it and, he hopes, act.

Shippen Geer  
President  
InterOcean Publicity, Inc.  
New York City

To the Editor:

Your editorial should be read and understood by everyone associated with the space industry.

I represent a support facility (communications) serving a major missile/space contractor. The pride of accomplishment of their efforts is felt by our craftsmen and management.

Unfortunately, a large segment of the general public views these industries as cost-plus monsters devouring hard-earned tax dollars.

Few people seem to realize that Missile/Space companies invest vast sums of capital money in research and development, feasibility studies, etc.

My own opinion of this industry has changed after closer association with top-flight managers that I have found in many instances to be dedicated to National Survival.

E. M. Armstrong  
San Francisco

### Splitting Gimbals

To the Editor:

The word "gimbal" used in the table on page 113 of M/R, July 17 is misspelled, I believe. My dictionary says "gimbals." Getting a gimbal should be about as difficult as getting a scissor or a trouser.

By the way, you will be terribly interested to learn that a gimbal ring is "a single gimbal, as that by which the cockeye of the upper millstone is supported on the spindle." Does this make you gimble?

Charles E. Dills  
Washington, D.C.

P.S. I think you have a very good maga-

missiles and rockets, September 11, 1961



zine. I write for a technical magazine myself, so I have some reason to think I may make some judgment.

*The word "gimbal" was used three times in the chart—in every case as an adjective. Like it takes two scissor blades to make a scissors, two trouser legs per pair of pants. Will gamble this makes you gambol.*—Ed.

## Vanishing West Ford?

To the Editor:

The current squabble between the radio astronomers and the Military over the seeding of a belt of reflecting needles for scatter communication might be resolved by using a metalized high-vapor-pressure organic material. The needles could be designed to dissipate as gas and dust over a 30-to-60-day period. Meanwhile, the Military could have tested the concept. As this is supposedly more a test than an initially permanent system, this approach ought to make all factions reasonably happy.

Ed Dingeman  
Littleton, Colo.

## Inadequate EED's

To the Editor:

"MR-4 Winds Up Suborbital Series" (M/R, July 31, p. 16) reports that NASA officials have fluffed off the escape hatch malfunction, possibly caused by R-F energy initiating the electro-explosive devices, as if it were relatively unimportant. Perhaps, to the overall program, it was. But certainly not to the individual (Astronaut Grissom) whose life hung in the balance or to (the scientists) who lost the information in the capsule.

Maybe NASA is determining the cause. Even so, it seems to me that NASA should be aware of the seriousness of the effect of electromagnetic radiation on the functioning of electro-explosive devices (EED's) being used in missiles, etc. They should be aware of the fact that the Air Force, Navy and Army Ordnance have been actively engaged in studying R-F's adverse effects on EED's.

I can speak with experience, having been actively involved in such work for three or four years. Also, I happen to know that NASA does not have personnel who have such experience and therefore I can't cope with the technical aspects of the situation.

This disturbs me, since nickel-and-dime EED's are finding their way into million-dollar programs. They are inadequately manufactured, tested and qualified.

I know this problem is quite complex, but considering the exposure of such services to the present-power electronic apparatus and the more powerful of the future, NASA should at least do something more than "put it down as an operational problem not requiring any design changes."

S. C. Piccoli  
Philadelphia

## Hunting for the Snark

To the Editor:

In looking over the recent M/R Fifth Annual World Missile/Space Encyclopedia, I could not find the *Snark* listed. I would be interested to know why it was not mentioned.

J. McWilliams Stone  
The DuKane Corp.  
St. Charles, Ill.

*The Snark program is being discontinued.*—Ed.

## From Fiftieth State

To the Editor:

Because there's been a great deal of talk lately concerning establishment of a major missile base in Hawaii, you may be contemplating some sort of a story on the 50th state.

We hope so, and we hope that the attached economic report (just off the press) may be of use to you.

Our "Shoemaker Report" circulates widely among bankers and businessmen on the mainland—but this is the only copy we are sending to any missile/space engineering magazine. Reason: Pacific Missile Range friends assure us that MISSILES AND ROCKETS is the leading publication in the field.

Aloha,  
Barbara Pike  
Bank of Hawaii  
Honolulu

## Titan II Guidance

To the Editor:

Reference is made to the article on the *Titan II* system in the June 19 issue of M/R.

The article states that IBM was responsible for the development of the complete guidance checkout and launch equipment for the system. In order to set the record straight, it should be stated that IBM developed only that portion of the ground checkout equipment associated with the airborne computer. The remainder, which is by far the majority, was developed by AC Spark Plug.

John Sheldrick  
Senior Project Engineer  
AC Spark Plug Division  
General Motors Corp.  
Milwaukee

## Youthful Appraisal

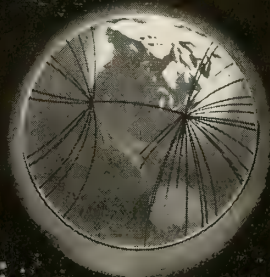
To the Editor:

I found your Aug. 14 editorial a very well done piece of work. It said what should have been said a long time ago. If more articles like this were written, it might do a lot of good. The American people have to finish what President Kennedy started. If President Kennedy hadn't done what should have been done a long time ago, we really would have had woes.

Bob Goldich  
(Age 10¾)  
Palo Alto, Calif.



41 years' experience in building and operating global communication networks (serving 99 countries) gives RCA unique capabilities in space-age communications. Talk with us if your responsibility includes the development of international communication systems between command and satellite tracking stations. Write or telephone RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4, Tel. HANover 2-1811, Area Code 212.



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# the HEART



**A PRIMARY SYSTEM** of the USAF DYNA-SOAR is Sundstrand's Cryogenic Accessory Power Generation Unit—supplying a continuous lifestream of electrical and hydraulic energy—powering all equipment and keeping the vehicle “alive”.

System contractor for the Dyna-Soar manned space vehicle is The Boeing Company. Boeing selected a dynamic cryogenic system because:

1. This system is ideally suited to provide power and cooling for manned space vehicles. High energy cryogenic propellants offer maximum specific impulse, plus a heat sink capability making possible a simple and reliable cooling system.
2. A dynamic cryogenic system requires no orientation, no shielding, nor special launch stowage—creates no aero-dynamic drag—and can be operationally tested *on the ground*.

The successful 3-year development program of a multi-stage single disk turbine for the Air Force contributed to the selection of Sundstrand for the accessory power unit.

Regardless of the nature of the mission required to reach future space goals, Sundstrand's technical capability will enable man to proceed successfully.

VISIT THE ARS  
SPACE FLIGHT REPORT  
TO THE NATION  
BOOTH NO. 542



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A DIVISION OF THE SUNDSTRAND CORP.  
DENVER 21, COLORADO

# The Countdown

## WASHINGTON

### 'Peaceful' Space Hopes Dead

The United States is abandoning hope of arriving at a United Nations agreement with Russia to use space for "peaceful" purposes. This is apparently the reason why NASA is now disbanding its Office for U.N. Conference, headed by former *Vanguard* boss John P. Hagen. Hagen's group was formed almost two years ago in support of the proposed U.N. Committee on the Peaceful Uses of Outer Space, which never has been organized because of Russian insistence on dominating the various subcommittees. One of the prime objectives of the U.N. committee was to sponsor a world-wide conference on space—a prospect that now seems dead, indeed. Hagen is expected to take another post within NASA.

### Tomahawk: A New Attack on Tanks

The Army is understood to have Martin studying a new light antitank missile called *Tomahawk*. The missile presumably would be a successor to such antitank missiles as *SS-10* and *Entac*.

### Fabmids Decision Pending

A decision on the next step in the development of *Fabmids*—the Army's proposed field antimissile missile—is expected within a matter of months. The story being passed along is that the decision could come before Jan. 1. *Fabmids* is expected to interest NATO.

### Zeus at Bat at Pt. Mugu

The Army is about to open the next major phase in testing *Nike-Zeus*. All three stages of the Western Electric antimissile missile are to be fired for the first time in flight tests at Pt. Mugu, Calif. The tests originally were scheduled to begin last month. The new target date: before mid-September.

### On the Pad

NASA is ready to make another attempt this week to orbit an unmanned *Mercury-Atlas* capsule. Problems with the *Atlas* program that forced postponement of the launch Aug. 22 now are said to be cleared up. . . . Upcoming in October: the first *Saturn* flight; an Air Force *Blue Scout*; *Ranger II*; the first *Orbiting Solar Observatory* (aboard an *Atlas-Agena B*), and an ionosphere electron-density satellite.

## INDUSTRY

### Polaris A-3 Still 'A-OK'

Published reports that the 2500-mile *Polaris A-3* is in trouble and may have to settle for a shorter range are being flatly denied. COUNTDOWN is told that although there have been problems with the hotter propellant—as shown by some mixing plant explosions recently—the Navy still expects to meet the 1964 operational date for the *A-3* with no compromise in range.

missiles and rockets, September 11, 1961

## NASA and Basic Research

Some NASA officials hoping to beef up the nation's basic research capacity are considering asking Congress for authority to build laboratories and other facilities at educational institutions, and to fund direct fellowships.

### Front Office

Minneapolis-Honeywell and the British Aircraft Corp. are forming a joint organization—BAC-Honeywell Inertial Guidance—Europe, headquartered in Paris, to develop, manufacture and market inertial systems for missiles and aircraft. . . . Lockheed now has authority to issue fixed-price purchase orders and subcontracts up to \$100,000 without prior government approval (previous limit was \$25,000). . . . Rocketdyne Division of North American Aviation has set up three new product operations—Research, Nuclionics and Space Engines.

### Florida Turns On Hard-Sell

With the expansion of Cape Canaveral under way for the U.S. lunar program, Florida industrial promoters are banging on the doors of missile/space firms to lure them southward. The huge NASA buildup in facilities is expected to bring a wholesale influx of propulsion, electronics and service companies into the Orlando-Cape area.

### R&D Intelligence

Henri Hodara of Hallicrafters thinks re-entry communications "blackout" can be licked by using a magnetic field to open up a "window" in the plasma sheath through which radio waves can pass. . . . AEC scientists expect *Vela Hotel* to be able to detect a one-megaton nuclear blast in space at three times the earth-sun distance—unless background radiation introduces a new element of uncertainty.

## INTERNATIONAL

### British Missiles to Germany

The British are beefing up their missile forces in West Germany. The Royal Artillery's 36th Guided Weapons Regiment equipped with *Thunderbird* anti-aircraft missiles is being redeployed this month. There are two *Corporal* regiments at Dortmund, Germany.

### Resentment Toward Blue Streak

COUNTDOWN hears that French technicians involved in the European Space Club are expressing rather strong opinions against using the British *Blue Streak* as a satellite booster. They also resent the choice of Woomera as the test center and the reported choice of Farnborough as a center for space research.

### Overseas Pipeline

A new radio telescope weighing 1350 lbs. and more powerful than Britain's Jodrell Bank will go into operation at the end of next month at Parkes, New South Wales. . . . The Dutch and Belgian governments are planning to build a \$2.8-million radio-telescope 20 times more discriminating than Jodrell Bank. . . . Some British officials are worrying that U.S. plans for global communications satellites will ruin Britain's international communications business.





## TAMING THE WILD BLUE YONDER

Primary responsibility for research, development, production, testing and evaluation of the Air Force's newest weapons systems—this is the mission of the recently created Air Force Systems Command. To its men—our defense architects—this mission presents the eternal challenge . . . that of taming the wild blue yonder.

# AFSC

In pursuit of this challenge AFSC must call upon the vast resources of industry and of education, as well as those of the military. AC Spark Plug is being called upon to develop and produce the small, yet highly accurate inertial guidance system for the TITAN II. This is but one example of American industry and government working together so peoples of the world may live together—in peace.

**AC SPARK PLUG  
THE ELECTRONICS DIVISION  
OF GENERAL MOTORS**



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*AC*hiever inertial guidance systems for Titan II, Thor and Mace. Bombing navigation systems for the B-52 and B-47.

If you are an experienced radar systems engineer interested in working on the B-52 Bombing Navigational System Integration Program, please contact Mr. G. F. Raasch, Director of Scientific and Professional Employment, 7929 South Howell, Milwaukee 1, Wisconsin. All qualified applicants will receive consideration for employment without regard to race, color, creed or national origin.



## All-DOD Purchasing Agency to be Set up Soon

The Defense Department moved last week toward establishing a Defense Supply Agency that eventually could handle all common procurement for the Armed Forces.

The long-range effect of the move on the Missile/Space Industry was not immediately clear.

Some central procurement of electronic supplies is expected. Another possibility: rocket fuels.

## Senate to Probe Program

The Senate Space Committee will hold a series of hearings starting Sept. 26 on the national space program.

Sen. Robert S. Kerr (D-Okla.), committee chairman, said the hearings will be concerned initially with a review of the *Saturn* and *Centaur* launch vehicle projects.

This will be followed, he said, by an examination of the communications satellite program, including the relationship between NASA, other government agencies and industry.

Other aspects of the space program will also be considered.

## Lockheed's Gross Dies

Funeral services were held last week for Robert E. Gross, chairman of Lockheed Aircraft Corp., who died Sept. 3.

Gross, who was 64, built Lockheed into the 28th largest industrial firm in the nation. He began with a bankrupt aircraft company purchased by himself and a group of associates in 1932 for \$40,000.

Headquartered at Burbank, Calif., Lockheed now employs 66,500 persons in aircraft, missiles, spacecraft, electronics, shipbuilding and other fields. It has net assets of \$548 million and gross sales of more than \$1 billion.

(See editorial, page 46)

## Surface Effect' Vessel

The Maritime Administration has missiles and rockets, September 11, 1961



## Leashed Bloodhounds at Farnborough

*BLOODHOUND* anti-aircraft missiles were displayed at Farnborough (see p.18) as Bristol/Ferranti revealed that Bloodhound II could kill at "well under 1000 ft."

let a design contract for a "surface effect ship" envisaged as the possible forerunner of surface-skimming warships.

The craft, which will travel above either water or land on a cushion of air, will be designed by Vehicle Research Corp., Pasadena, Calif., under a \$370,000 contract. Construction may start late next year.

## Japan Working on Mu Rocket

The Japanese are reported to have the development of a huge scientific *Mu* rocket under study. It will be the successor to the 66-ft. *Lambda*.

Few details of the *Mu* are available. However, it is reported to be designed to reach altitudes of about 2600 miles.

The four-stage *Lambda* is expected to be completed about 1963.

## Stahr Calls for Imagination

Army Secretary Elvis J. Stahr called on industry last week to use "greater imagination" in developing new Army weapons.

"Eschew the conservative approach," Stahr told some 4000 military men and industry representatives attending the 1961 annual meeting of

the Association of the U.S. Army in Washington.

The annual AUSA report noted with careful enthusiasm the recent increases in Army funding for modern equipment and increased manpower. However, it added that more support is needed for CBR development and *Nike-Zeus* should be put into production.

One of the convention's highlights was the public display of "BIRDIE"—the Army's new vest-pocket air defense system. (See p. 21.)

## NASA Gets Saturn Plant

NASA announced that it is taking over a government-owned plant at Michoud, La., for use as a site to produce *Saturn*-class vehicles.

The plant will be used to build the first stage of the *Saturn C-1* booster and the two-F-1-engine first stage of advanced *Saturn* vehicles.

When in full production it is expected to have at least 15,000 employees.

No contractor has yet been selected to build the stages. A date for a bidders conference has been delayed by NASA indecision as to whether one firm should be picked to build



GROSS



SHOWN ¾ SIZE



# WIDE ANGLE FLOATED RATE INTEGRATING GYRO FOR CONTROL APPLICATIONS

Designed for strapdown control applications, this miniature wide angle precision gyro provides accurate and reliable performance in extreme missile environments.

A newly developed high viscosity damping fluid with good low temperature characteristics permits large angular inputs without loss of reference and eliminates the need for paddle type damping devices. Low uncompensated drift levels are obtained through the use of externally controlled adjustments of mechanical mass unbalance and fixed torque drift. A unique torquer with external adjustments makes possible high torque linearity including at the "off null" position. The spin motor will operate satisfactorily from a three phase or single phase 400 cps power supply.

Actual test data taken on a group of these gyros demonstrate the capability of this device as the most accurate and stable control gyro now available. Typical test results include the following average values:

Uncompensated mass unbalance level— $0.35^\circ/\text{hr/g}$  avg.;  
Uncompensated restraint level— $0.4^\circ/\text{hr}$  avg.; Torquer linearity  
0.017% avg. proportional from  $0.1^\circ/\text{sec}$  to  $5^\circ/\text{sec}$ .

## TYPICAL CHARACTERISTICS

|                                             |                          |
|---------------------------------------------|--------------------------|
| Angular momentum (gm cm <sup>2</sup> /sec.) | 100,000                  |
| Operating temperature                       | 180°F*                   |
| Torquer scale factor (°/hr/ma)              | 800                      |
| Input angle                                 | Up to 30 degrees         |
| Transfer function (mv/mr)                   | 3.75 at gyro gain of 3.0 |
| Dimensions: lengths                         | 3.56"                    |
| body diameter                               | 1.98"                    |
| mounting diameter                           | 2.15"                    |
| Weight                                      | 1.2 pounds               |

\*lower operating temperature as required

Write for complete data



**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

Little Falls, New Jersey

both stages of the booster.

It is also reported that a contract award for the four-J-2-engine second stage of the *Saturn C-3* will be announced in the next few days.

Firms in the running include Aerojet, General Dynamics-Astronautics, Douglas and North American.

## Ranger Flight Useful

*Ranger I* fell into the earth's atmosphere and burned up on Aug. 28.

Launched on Aug. 26 from Cape Canaveral, the lunar spacecraft made 101 orbits of the earth and traveled over 3 million miles.

NASA said that the flight proved that the spacecraft orientation equipment, communications and electronic systems worked well.

*Ranger I's* short lifetime was due to a malfunction in the *Agena B* stage, which failed to send the spacecraft into the long-earth orbit planned.

## Late Contract Items:

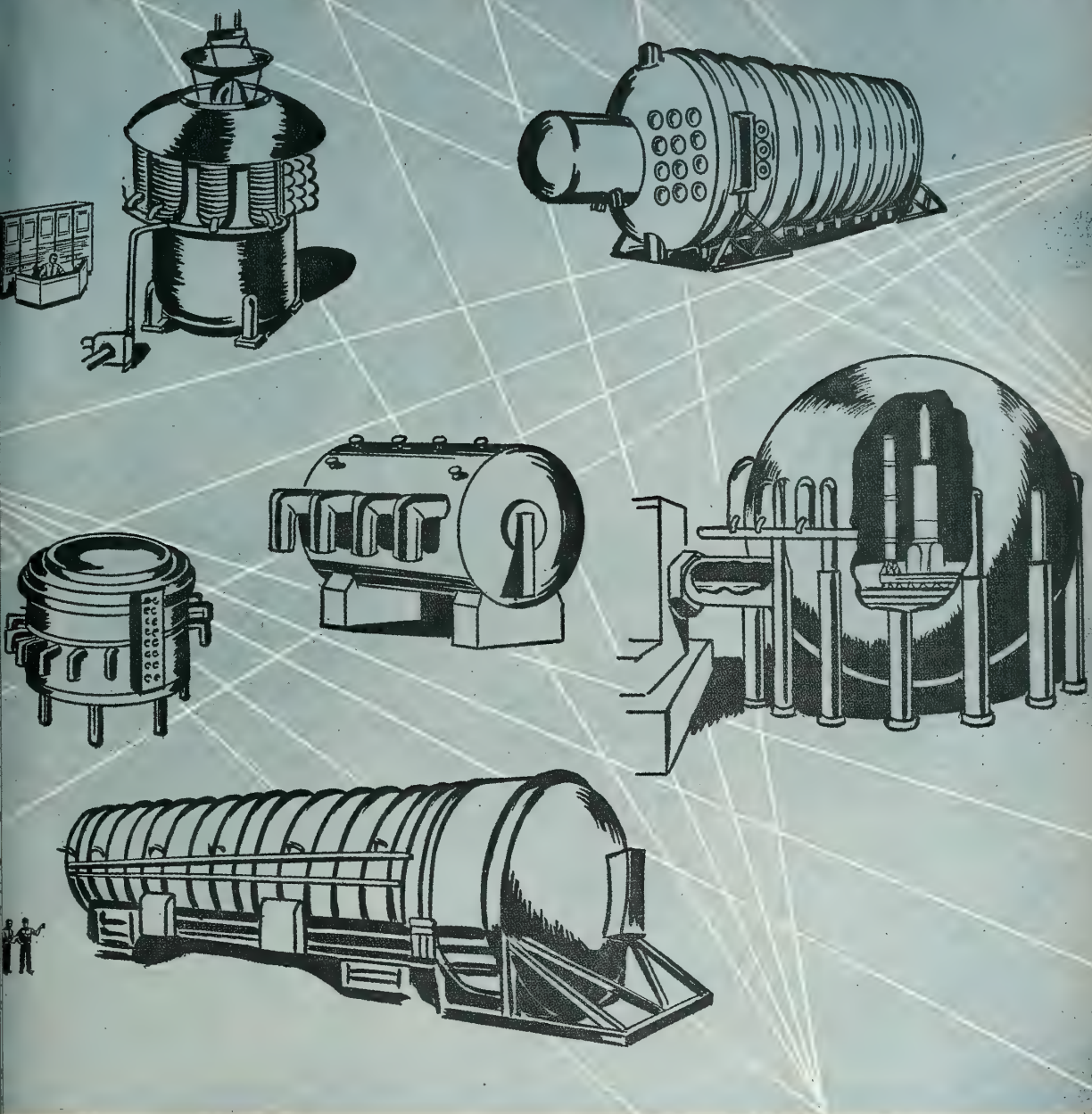
- **Martin Co., Baltimore**—A \$99,000, six-month Navy study contract for design of advanced submerged submarine navigation aid. System is proposed for installation in AUTECH. Both passive and active aids will be considered. Martin said findings to date suggest best navigation aid may use a "bottom bounce" method of projecting underwater sound.

- **Martin Co., Baltimore**—A \$310,000 NASA contract to build some 50 heat exchanger units for *Saturn C-1* boosters.

- **Avco-Everett Research Laboratory**—A \$1,582,824 subcontract from Bell Telephone Labs to conduct a program associated with identification techniques for *Nike-Zeus*.

- **Thiokol Chemical Corp.**—A \$1,033,000 Navy award for production of *Bullpup B* Model LR 62 RM-2 packaged liquid engines. First flights of the "B" powered with this engine will be made from A4D carrier-based aircraft.

- **Vitro Engineering Co.**—Picked as contractor to AEC (amount to be negotiated) for architectural and engineering design contract for nuclear rocket engine maintenance and disassembly building. The building will be the first component of the National Nuclear Rocket Development Center which will probably be built at the AEC's Jackass Flats test site.



## Down-to-Earth Space Chamber Designs

These sketches demonstrate CB&I's ingenuity in designing structures to simulate outer space. Eleven such CB&I field-erected structures are in service or under construction, simulating conditions beyond the stratosphere. CB&I's 70 years of experience in the design, fabrication and construction of steel structures assures capable responsibility from conceptual design of environmental chambers through start up. Write for Bulletin G-53. Chicago Bridge & Iron Company, 332 S. Michigan Ave., Chicago 4, Illinois. Offices and subsidiaries throughout the world.

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created them

*Serving leaders in the fields of Aerospace, Nuclear Power, Chemistry, Petroleum, Cryogenics, Hydroelectric Power, and Municipal and Industrial Water Supply.*



**New threats, chances . . .**

# Nuclear Test Revival to Bring

**U.S. as well as Soviets can make good use of more explosions; maneuvers may be aimed at Polaris subs**

by James Baar

THE RESUMPTION of nuclear testing by Russia and the United States is certain to result in radical changes across the board in U.S. plans for development and deployment of missiles.

Pentagon specifications and industry proposals will have to be sharply adjusted to meet the problems and opportunities that will be created by the coming decrease in payload weights and the increases in payload power.

This is the still somewhat obscured but basically life-and-death significance of the loosing of a Soviet nuclear explosion in a remote corner of Kazakh Sept. 1.

• **Dread 'first' due?**—Meantime, the closely related Russian maneuvers in the Barents and Kara Seas could be the opening gun in an undeclared sea war against the *Polaris* submarine fleet.

The Russians strongly hinted that the maneuvers—running from Sept. 10 to Nov. 15—will include the use of nuclear-tipped missiles. The Soviet Defense Ministry has warned "the owners of . . . foreign ships that it will not bear responsibility for any material damage that might be caused to ships or planes crossing the danger zone."

The Barents and Kara Seas, as well as the neighboring Norwegian Sea, have long been considered to be likely deployment areas for *Polaris* submarines. With the sailing Aug. 28 of the *Abraham Lincoln*, the number of *Polaris* submarines within striking distance of the Soviet heartland has grown to five.

If Russia launches nuclear-tipped missiles in the Arctic war games, it will be the first time that such a missile has been launched with a live warhead under tactical conditions.

• **Underground harvest**—The data from these launchings are only a small part of the gains that Russia is expected to achieve by resuming nuclear tests in the atmosphere. But the gains from underground testing, in which many experts believe Russia has been secretly engaged for some time, are also impressive.

Nuclear underground testing is expected to make it possible for the United States to:

—Increase greatly the yield-weight ratio of missile warheads. This means that the punch of *Minuteman* and *Polaris* warheads can be increased. It also means that, as an alternative, ranges can be extended. And it means that highly mobile, land-roving ICBM's can be developed more easily.

—Test designs of nuclear warheads tailored to prospective and recently developed defense systems. This means that the United States no longer will have to rely on test data pre-dating the deployment of *Atlas* and *Polaris*—let alone *Titan*, *Pershing* and *Minuteman*.

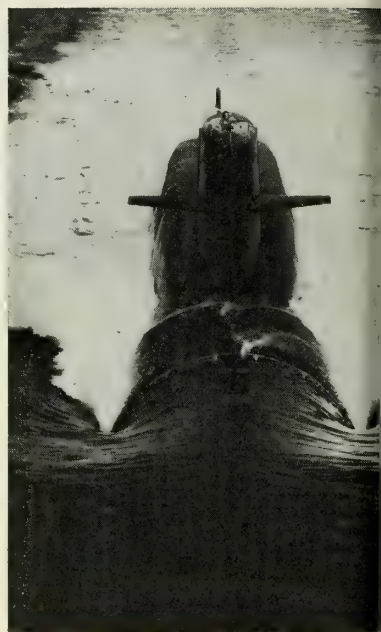
—Develop possibly revolutionary types of nuclear weapons, particularly tactical warheads for use on the battlefield by small Army units. Also develop "cleaner" nuclear warheads that would enable commanders to confine damage to a specific target area.

• **Aerial bonuses**—Nuclear testing by Russia in the atmosphere, besides making possible the testing for the first time of new nuclear-tipped missiles and antimissile missiles from launching to detonation, also is expected to make it possible for the Soviets to:

—Develop great "Doomsday" warheads, ranging from 30 to 100 megatons. Despite some public disclaimers as to the military value of such warheads, they will enable Russia to make obsolete much of the planning and construction on U.S. fixed, hardened missile sites.

—Test the ability of hardened missile sites to withstand nuclear attack.

—Make all the advances that can be made from underground testing and perfect them further. This, of course, is of interest to Russia only if these



## Reds Maneuver

*THE RUSSIANS are planning to conduct the world's first nuclear missile maneuvers*

gains have not already been made secretly during the test ban.

The Soviets detonated four low-to-intermediate-range nuclear devices in the first six days of their current test series.

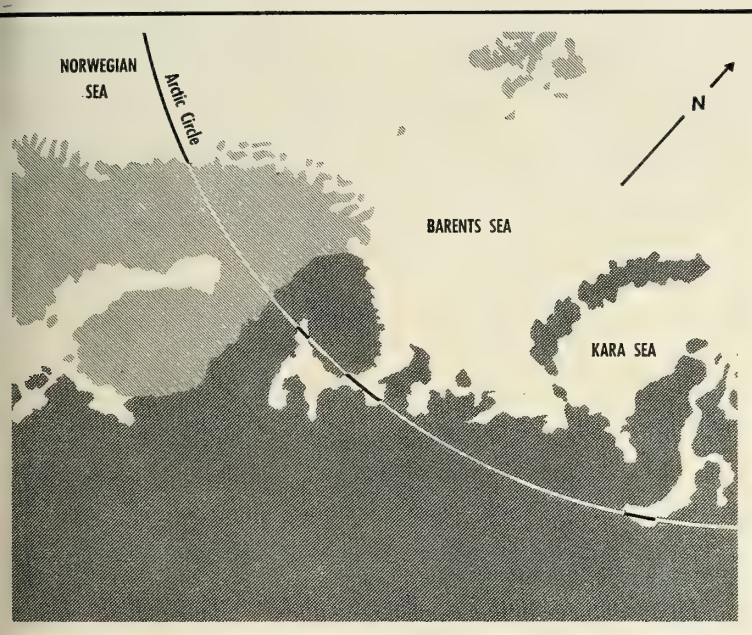
• **Next move ours**—President Kennedy announced the resumption of U.S. underground tests after the third Soviet nuclear blast. The tunnels in Nevada where the underground tests will begin this month have been kept ready and improved since they were last used in 1958.

The AEC conducted a total of four underground tests in the 1958 series. The first U.S. underground test took place the year before. The last of the 1958 series was the biggest: about 20 kilotons.

There was no immediate indication

missiles and rockets, September 11, 1961

# Drastic Missile Revisions



## Polaris Stamping Ground

in the Arctic seas—one of the areas where the Robert E. Lee (left) and her sister

Polaris-carrying submarines are believed to be on station.

how big the U.S. tests would be. However, AEC scientists have talked in the past of the possibility of conducting more than 100-kiloton tests underground—even in secret.

Because of the importance of the gains that will accrue from tests in the atmosphere, the United States is expected to follow Russia's lead and conduct tests there as well as underground.

• **Voices of warning**—Also, there is a serious question as to whether the United States could afford not to resume tests in the atmosphere that would at least match those conducted in Russia. As Sen. Clinton P. Anderson (D-N.M.), former Chairman of the Joint Congressional Atomic Energy Committee, put it:

"As it now stands, the Russians could go on and shoot 10 or 15 shots

and finish a lot of their preliminary work (and) then announce: 'We'll quit if you do.'

"We must announce the program and stay with it."

Anderson was warmly supported by many key members of the Senate and House. A number of them have been pressing for months for U.S. resumption of tests, regardless of what Russia did openly, on the grounds that the Soviets probably were cheating.

The pressure had begun to mount last fall. At that time probably no one in authority put the problem more bluntly than AEC Commissioner Robert E. Wilson:

"Any country which decides to proceed with further testing and, hence, a systematic weapons improvement program, while we continue to observe a

moratorium, is likely in a few years to take our place as the foremost nuclear power in the world."

At the time the nuclear test moratorium went into effect in 1958, the United States had conducted 153 nuclear weapon development tests and dropped the first two A-bombs on Japan in World War II. Russia was reported to have conducted 55 tests; Britain, 21. Since then, France has conducted four.

• **Lost ground**—However, the fact that the United States has conducted more tests than all other nations combined is not the full story.

Only twice has the United States ever launched a missile with a nuclear warhead and determined whether it would explode over a target. Both times occurred in the Pacific in August, 1958. The missile was reported to be a *Redstone*; the warhead in the megaton range.

Therefore, none of the great missiles—*Atlas*, *Polaris*, *Titan* and *Minuteman*—on which U.S. deterrent power will rest in the 1960's has ever been completely tested in the way that a rifle or an artillery piece is tested.

Finally, the vast complex of hardened ICBM bases is being built on the basis of calculations made with 10-megaton warheads in mind.

And, last but certainly not least, there is the intriguing question of how the 100-megaton warhead would be delivered. Soviet Premier Khrushchev has boasted that the same rockets that launched the *Vostoks* could be used. But there have been strong hints that the *Vostoks* themselves would be the carrier.

Hundreds of unmanned *Vostoks* could be put into orbit with their terrifying loads. Other *Vostoks* with men might help direct the space-to-earth battle at the desired time.

The meaning of the mushroom clouds rising near Semipalatinsk in Kazakh is clearly the beginning of a new and far more desperate lap in the East-West arms race. The goal: New and better missiles—and spacecraft. ♣



# NASA Reviewing Costly Contracting

**Space agency joins DOD's drive to cut waste; most of problems blamed on the cost-plus-fixed-fee award**

by Hal Taylor

NASA HAS BEGUN a review of its contracting procedures amid indications that the space agency will make use of incentive-type contracts for the first time.

The review was ordered by Administrator James E. Webb in an effort to cut R&D costs. Some firm results can be expected in the next few months.

Officials—already at grips with the problem—report that some cost-plus-incentive-fee contracts will be awarded in the near future. If these are success-

ful, it is likely that more and more will be used to replace the current cost-plus-fixed-fee contracts which the space agency blames for most of its "high cost" troubles.

NASA thus is joining the Defense Department's attack on the wastefulness of government procurement. In June, DOD procurement officials served notice on defense contractors that some method must be found to cut costs.

Space agency officials wholeheartedly agree.

Ernest W. Brackett, director of NASA's Procurement and Supply division, said that the cutting of costs through better contracting methods is a "serious problem and one which we will have to do something about." He said that a full-fledged review of contracting policy has started and "we hope to come up with some ideas."

• **Root of trouble**—Prime target of the review is NASA's present policy under which contracts calling for the payment of costs plus some predeter-

mined profit are used almost exclusively in procurement.

In Fiscal 1961, 83% of NASA's total procurement of \$363 million was awarded on a cost-plus-fixed-fee basis. Cost-plus-firm fixed price contracts accounted for another 16%. The other 1% was split up among five other, similar cost-type contracts.

The primary advantage of incentive-type contracts is that the contractor receives a higher profit for savings in cost or superior performance. Conversely, his profit is reduced if the costs are too high or his performance is not up to standards.

The big problem in using such contracts is that a wealth of experience must be chalked up before the agency will have sufficient material with which to compare a contractor's cost claims and performance.

This is especially true for a comparatively new agency, like NASA.

Brackett refuses to say what changes in contracting procedures will result.

## HISTORY OF THE BIG BOOSTER DOLLAR (in millions of dollars)

|               | NASA<br>FY '59 | NASA<br>FY '60 | NASA<br>FY '61 | NASA<br>FY '62 | Total<br>NASA | DOD<br>through<br>FY '61 | DOD<br>FY '62 | AEC<br>through<br>FY '61 | AEC<br>FY '62 | GRAND<br>TOTALS |
|---------------|----------------|----------------|----------------|----------------|---------------|--------------------------|---------------|--------------------------|---------------|-----------------|
| <b>SATURN</b> |                |                |                |                |               |                          |               |                          |               |                 |
| R&D           | —              | 9.4            | 118.1          | 224.2          | 351.7         | ↓                        | —             | —                        | —             | ↓               |
| Construction  | —              | —              | 46.5           | 39.7           | 86.2          | ↓                        | —             | —                        | —             | ↓               |
| In-House      | —              | 2.9            | 49.2           | 68             | 120.1         | ↓                        | —             | —                        | —             | ↓               |
| <b>TOTAL</b>  | —              | 12.3           | 213.8          | 331.9          | 558           | 101.3                    | —             | —                        | —             | 659.3           |
| <b>NOVA-L</b> |                |                |                |                |               |                          |               |                          |               |                 |
| R&D           | 10             | 24.2           | 40             | 57.3           | 131.5         | ↓                        | —             | —                        | —             | ↓               |
| Construction  | —              | 4.5            | —              | 24             | 28.5          | ↓                        | —             | —                        | —             | ↓               |
| In-House      | —              | —              | .1             | .1             | .2            | ↓                        | —             | —                        | —             | ↓               |
| <b>TOTAL</b>  | 10.0           | 28.7           | 40.1           | 81.4           | 160.2         | .8                       | —             | —                        | —             | 161             |
| <b>NOVA-S</b> |                |                |                |                |               |                          |               |                          |               |                 |
| R&D           | .6             | 1.7            | 1.3            | 3.1            | 6.7           | —                        | ↓             | —                        | —             | ↓               |
| Construction  | —              | —              | —              | —              | —             | —                        | ↓             | —                        | —             | ↓               |
| In-House      | —              | —              | —              | .1             | .1            | —                        | ↓             | —                        | —             | ↓               |
| <b>TOTAL</b>  | .6             | 1.7            | 1.3            | 3.2            | 6.8           | —                        | 62            | —                        | —             | 68.8            |
| <b>ROVER</b>  |                |                |                |                |               |                          |               |                          |               |                 |
| R&D           | 3              | 4              | 8.7            | 25.5           | 41.2          | ↓                        | —             | ↓                        | ↓             | ↓               |
| Construction  | —              | 1.5            | —              | 15             | 16.5          | ↓                        | —             | ↓                        | ↓             | ↓               |
| In-House      | —              | —              | .2             | .2             | .4            | ↓                        | —             | ↓                        | ↓             | ↓               |
| <b>TOTAL</b>  | 3              | 5.5            | 8.9            | 40.7           | 58.1          | 7.2                      | —             | 124.1                    | 51.75         | 241.2           |

HOW U.S. HAS SPENT more than \$1 billion over the past two years—and has yet to fly a big space booster—is shown in this table compiled from recently published testimony before the

Senate Space Committee. The table indicates that in the next year or two, under the accelerated moon effort, these four major programs will easily eat up \$1-2 billion per year.

# Procedures

from the review—other than to point out that procurement officials at the Goddard Space Flight Center are expected to award some cost-plus-incentive-fee contracts shortly.

Any other ideas, he says, will have to be checked first with legal counsel.

Other space agency officials said, however, that there is nowhere for NASA to go except in the direction of new types of contracts.

While admitting that the space

## Latest on Apollo Awards

NASA has released details on Apollo spacecraft contracting procedures which indicate that more than one major contract will be awarded.

Space agency officials said that one firm will be selected—from those asked to submit bids by Oct. 9—to perform research and development for the spacecraft's command and service modules.

The firm will also be responsible for system engineering and systems integration for all other contracts which may be awarded in the building of the lunar landing spacecraft.

In addition to the contract for a guidance and navigational control system already given to Massachusetts Institute of Technology, other contracts will probably include an orbiting laboratory module, a vehicle adapter for earth-orbiting missions and the development of a propulsion module for lunar landing missions.

Still more contracts are expected.

Agency's cost experience is small, they point out that NASA is chalking up some cost data on the *Aerobee* and *Scout* programs. This will also be increased as the *Saturn* and *Apollo* programs get rolling.

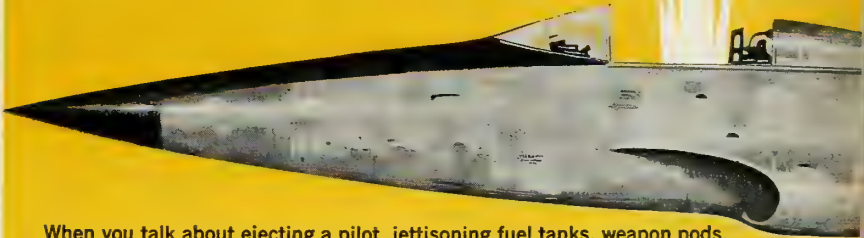
Among the types of contracts which they suggest NASA may be using in the future are the fixed-price incentive, cost-type incentive and Value Analysis.

The officials also said that there is a possibility that NASA may decide to inaugurate an entirely new type of contract. This could parallel the cost-plus-award-fee which the Defense Department is currently considering. Under that contract, a board of qualified judges could award up to 15% for exceptional performance—or deduct as much as 5% for poor performance. ❖

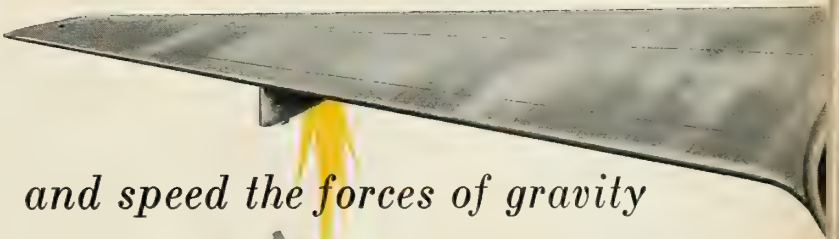
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## and speed the forces of gravity



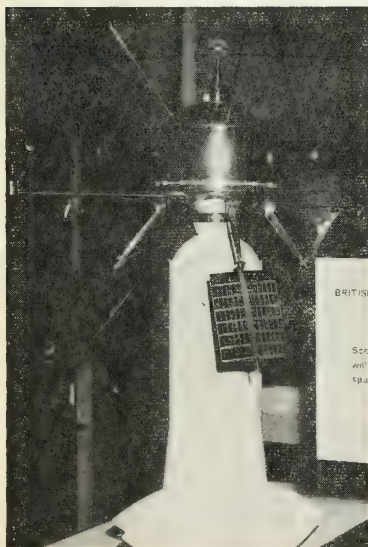
# GEMCO





# British Show Growing Array of Salable Missiles

**Photos taken at opening of British industry's big annual exhibition reflect widened production ability**



BRITAIN'S ionosphere satellite.

FARNBOROUGH, ENGLAND—British missile power went on display this last week at the Society of British Aircraft Constructors annual exhibition.

The Hawker Siddeley *Blue Streak* space booster dominated the display at the missile park. However, British Aircraft Corp.'s *Blue Water* received equal attention, particularly from visitors from the continent.

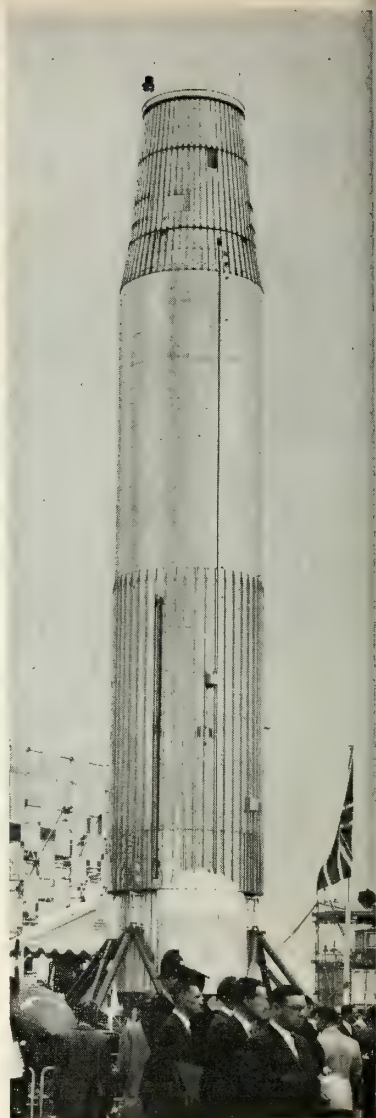
*Blue Water* is still considered one of Britain's hottest missile export items. It still is the chief contender with the U.S. *Sergeant* for adoption by NATO.

Short Bros. and Harland exhibited the *Seacat* ship-to-air missile. Both Sweden and West Germany have ordered *Seacats* for evaluation; it already has been adopted by Australia and New Zealand.

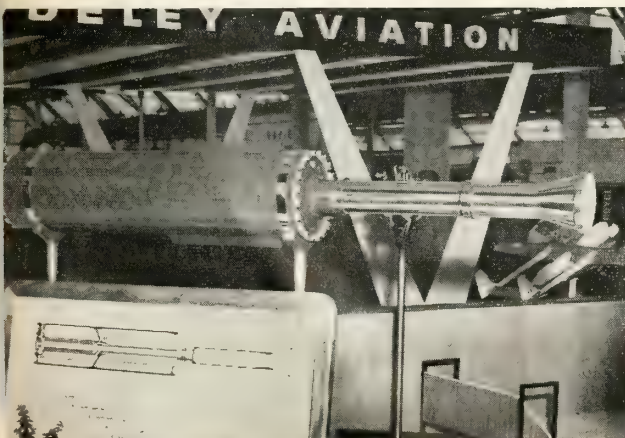
British Aircraft exhibited *Thunderbird* and *Bloodhound* surface-to-air missiles. Hawker Siddeley showed off its *Firestreak*, *Seaslug* and *Blue Steel* stand-off missile. *Red Top*, successor to *Firestreak*, also was displayed.

Among the antitank missiles were the Fairey *Malkara* and the British Aircraft *Vigilant*.

The *Vigilant* is reported to be under consideration by the Indian Army. The British Army has some 400 *Malkaras* on order.



MODEL of the *Blue Streak*.



DEHAVILLAND Spartan storable liquid rocket engine.



AUSSIE'S *Malkara* was also shown at Farnborough.

missiles and rockets, September 11, 1961

**In operation . . .**

# Army's 'BIRDIE' Air Defense Control

**Miniaturized Missile Master built by Martin  
helps to guard medium-size cities, military bases**

**by James Trainor**

A "VEST-POCKET" air defense system—designed to protect military installations or cities in the 600,000 population class—has been revealed by the Army.

Built for the Army Signal Corps by the Martin Co., the new system—described as a transistorized Missile Master—is already installed and in operation at Turner AFB, near Albany, Ga., and at the Army Air Defense School at Fort Bliss, Tex. It is scheduled for deployment at 17 additional locations in the near future. Location of these is classified until after they are operational.

Nicknamed "BIRDIE," for Battery Integration and Radar Display Equipment, it was shown in Washington last week at the annual meeting of the Association of the United States Army.

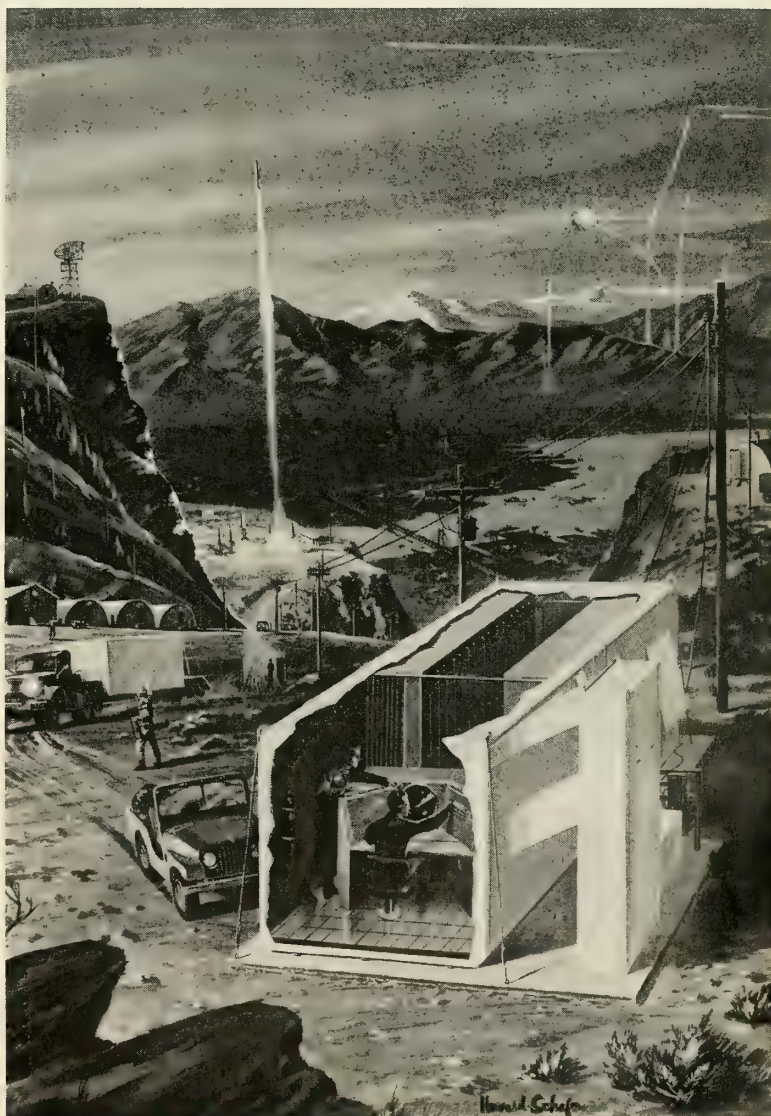
BIRDIE gives the Army a compact, transportable means of processing and distributing information about aircraft to guided missile batteries, and of coordinating the defensive fire of *Nike-Ajax* and *Nike-Hercules* missiles. Its principal advantage is that each of the systems can be tailored to the size of the local defense to which it is assigned at a reasonably low cost per system.

It will be tied by the Army's Air Defense Command (ARADCOM) into other air defense control systems such as NORAD thus integrating local Army defenses with the entire North American air defense complex. However, it can operate autonomously in the event that inputs from higher headquarters are interrupted.

- **Two styles**—BIRDIE uses 97% less space, 95% less power and 80% fewer personnel than its bigger brother, Missile Master. It consists of two types of equipment: the AN/GSG-5(V) and the AN/SG-6.

The former contains a storing and processing facility and track-while-scanning equipment for the continuous

*(Continued on page 43)*



**MARTIN ARTIST'S** conception of the U.S. Army BIRDIE air defense coordination system in action, helping to protect a metropolitan area against air attack.



*Opportunities for:*

# Aerospace Vehicles Engineers

The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

## Structures

**Senior Dynamicist.** Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

**Loads Analyst.** To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

**Reliability Analyst.** To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

**Stress Analyst.** To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

**Design.** Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environ-

ment and hand vacuum, plus a background in materials is desired.

## Heat Transfer

**Space Vehicle Heat Transfer.** Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

**Aerothermodynamicist.** Experience in hypersonic real gas dynamics, heat transfer, ablation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

## Equipment Installation

**Packaging and Installation Engineer.** To perform optimum packaging and installation design for missile and/or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

## Controls

**Optical Devices.** Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

**System Test.** To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

**Control System Analysis.** Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

**Circuit Design and Development.** Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

---

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler**, Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 76, California.

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# Technical Countdown

## ASTRONAUTICS

### Fences in Space?

According to a theory advanced by J. M. Boyer of Northrop's Radioplane Division, the trapped particles in the Van Allen radiation belts are actually caught in fences of long-wave radio signals and bounce back and forth between the fences like ping-pong balls. The current theory that the particles are trapped solely by the earth's magnetic field is inadequate, according to Boyer, because "radio telescopes have shown that space is one vast, unending bedlam of radio signals broadcast in all directions by celestial bodies." Both the trapped particles and the long-wave standing waves, according to this theory, originate in the sun.

## ELECTRONICS

### Army Receives New Combat Computer

A new general-purpose computer, called the Informer, has been delivered to the Army Signal Corps by IBM. Part of the Army's family of combat area data processors, the system fits into a 2½-ton truck and is designed for all-weather, all-terrain operation. Informer—for use with division, corps or army elements—can be adapted to missile checkout, logistical problems, intelligence data storage and retrieval, damage assessment and map compilation.

### Inertial Data System Guides X-15

An inertial flight data system—developed by Sperry Gyroscope Co.—has been used to guide the X-15 from launch through the hypersonic acceleration phase of the flight to controlled re-entry into the earth's atmosphere. Heart of the system is a three-gyro stable platform, incorporating advanced miniaturization of the electronic components and all its own power supplies and amplifiers. A lightweight computer digests and interprets this data and displays it pictorially for the pilot on specially-developed cockpit instruments.

### Computer Utilized for Saturn Pre-flight Tests

An RCA ground checkout computer system is being utilized at NASA's Marshall Center to develop automation techniques to insure higher vehicle reliability. It will decrease the time necessary for pre-flight checkout of the *Saturn* and other large multi-engine vehicles. The computer provides a real-time basis for monitoring and controlling *Saturn* tests, and provides both magnetic core and drum memories for storing the main program, processed data and emergency programs.

### Step-and-Repeat Photography Wins Favor

To facilitate rapid, accurate production of micro-miniaturized components for electronic circuitry, many firms are turning to step-and-repeat photography. This method—used to achieve multiple identical images from a single piece of original artwork—photographically reduces the complete pattern and then automatically steps up on the Misomex at the rate of 350 exposures per minute, to an accuracy of .001 inches over the entire exposure area. Repeating the process will achieve even further miniaturization.

## SUPPORT EQUIPMENT

### PACM Telemetry Under Study

Air Force is investing about \$¼ million in the study of potential PACM telemetering systems in spite of an industry consensus that the approach recommended by Aeronutronic won't prove practical. WADD feels that the combination pulse amplitude/pulse code technique does hold promise—and must be more fully explored before its feasibility can be decided. Most telemetering experts agree on the potential of PACM, but disagree on the approach.

### Mobile Tracking Mount Under Development

An automatic tracking mount—scheduled for operation in 1962—is being developed for the Navy by American Machine and Foundry Co. The mount will provide missile-tracking cameras with a greater degree of movement in elevation and azimuth, increasing accuracy and broadening photo coverage.

## ASW & SEABORNE ENGINEERING

### Bendix Gets Polaris Controls Award

Five automatic maneuvering control systems for *Polaris* submarines will be built for the Navy by Bendix's North Hollywood, Calif., Div. The system controls the submarine's steering and diving mechanism through a solid-state computer which receives signals from the speed, course and depth instruments. The computer in turn regulates electro-hydraulic valves in the steering, diving and fairwater planes.

### Marines Plan Amphibious Hydrofoil

A new type of amphibious support vehicle—able to "fly" across the water on hydrofoils and travel on land as a wheel vehicle—is being built by FMC Corp. for the Marine Corps. The versatile vessel will have retractable foils and wheels which will enable it to cut through the water at speeds in excess of 35 knots and travel on land at speeds of more than 25 mph. The craft—designated the LVHX2—will be used by the Marines to swiftly transport troops and equipment from ship to shore and then across country during the support phase of an amphibious operation.

## ADVANCED MATERIALS

### Bendix Gets Tape Controls Contract

The 11 numerically controlled profiling machines being purchased by Douglas under the Air Force Machine Tool Modernization Program will be equipped with \$750,000 worth of controls from Bendix Corp.'s Industrial Controls Section. Giddings and Lewis, and Sundstrand will provide the machine tools.

### Recovery System Passes First Test

Goodyear's Ballute inflatable drag device, successfully recovered a 500-lb. test missile from 100,000-ft. altitude. The Air Force program will ultimately test the balloon's ability to recover missile equipment at Mach 10. In the current phase, the ballute was released at 88,000 ft. and final stages of the descent were under parachute.





## advanced materials

# GE Geared to Build Huge Solid Cases

**Company says it has tools at Schenectady for 20-ft.-dia. case fabrication; Minuteman team at Evendale could serve in larger program**

by John F. Judge

CINCINNATI — General Electric is moving swiftly into the highly competitive large-solid-rocket motor case market—right up to 240-in.-diameter chambers.

R. H. Wettach, Jr., Manager, Solid Rocket Cases, says the firm already has functioning in its Schenectady generator shops most of the massive tooling necessary to fabricate the huge pressure vessels.

That facility has roll and weld capabilities, boring units handling up to 42-ft.-diameter pieces, and vertical lathes which easily work 16- and 24-ft.-diameter sections 12 to 14 feet high under the rail.

"Schenectady is essentially facilitized to handle a 160-in. case and 240-inch jobs wouldn't strain them a bit," says Wettach. Transportation problems are minimized by the department's location and past experience with large, heavy and delicate products.

There are many problems—the main one being adequate heat-treating furnaces. But the technology is new, and the first chambers will be largely R&D items. GE spokesmen are positive that solutions will be found without hampering operations to any great extent.

• **Case craftsmen**—GE's ace in the hole is the highly experienced team currently producing *Minuteman* first-stage motor cases at the Evendale, Ohio,

plant. This core of experts, proficient in the exacting detail work essential to the manufacture of large motor cases, could form the nucleus of the bigger Schenectady operation.

Apart from the *Nova* concept, Wettach says the Evendale plant can fabricate and heat-treat 100- and 120-in. cases. The new gantry heat-treat furnace is already strengthening 120-in. experimental cases from Excelco Development, destined for Grand Central Rocket Co.'s large booster programs.

In all probability, the 100-in. cases will originally be roll-and-welded, but Wettach feels roll forming will eventually take over because of the extreme advantage in eliminating the longitudinal seam.

For the 100-in. job, the case men are eyeing the AEC-owned equipment left from the ill-fated ANP program. Large vertical lathes and boring mills, bought for the nuclear plane project, stand idle at the other end of the huge GE Evendale facility and could very easily fit into a large case-fabricating process.

• **Components subcontracted** — In the *Minuteman* case production, GE farms out a great deal of the component machining. The forward head, center sections, aft head and closure are all machined by vendors and delivered to GE.



**LEFT:** Massive solid booster cases could be fabricated on the large vertical machine tools currently producing electrical gear at GE's Schenectady works.

The machined cylindrical preforms for the center of the case are roll-formed on a Cincinnati 75-x-100-in. Hydrospro. The working rolls have a travel of 104 in. and a horizontal movement of 42 in. The unit can finish a cylinder 78 in. across and 100 in. long. The tail stock will move 104 in. vertically, but also sideways to form cylinders 200 to 300 in. long. GE is not now forming complete center sections in the *Minuteman* program, but the machine has that capability. The cylinders are stress-relieved after machining. If two passes are necessary, this operation is performed twice.

Welding processes are carried out on a large Lewis machine with a Sciaky electro-welding head. Welding is automatic, but an operator can override the controls if something goes wrong.

The case, except for the aft closure, is then heat-treated in the huge 120-in. furnace GE constructed specifically for motor cases. The circular system includes a gantry-type furnace and seven pits. The furnace, with a 1030-kw power rating, can raise an 8000-lb. load of steel from 1000° to 1500°F in an hour. The unit can be set to any temperature up to 2000° with  $\pm 10^\circ\text{F}$  accuracy.

In the pits, there are two furnaces for combination preheat, tempering and stress relieving operations, one salt-quench station, one still-air quench station, one combination water-quench and rinsing station and two additional pits for future oil-quench.

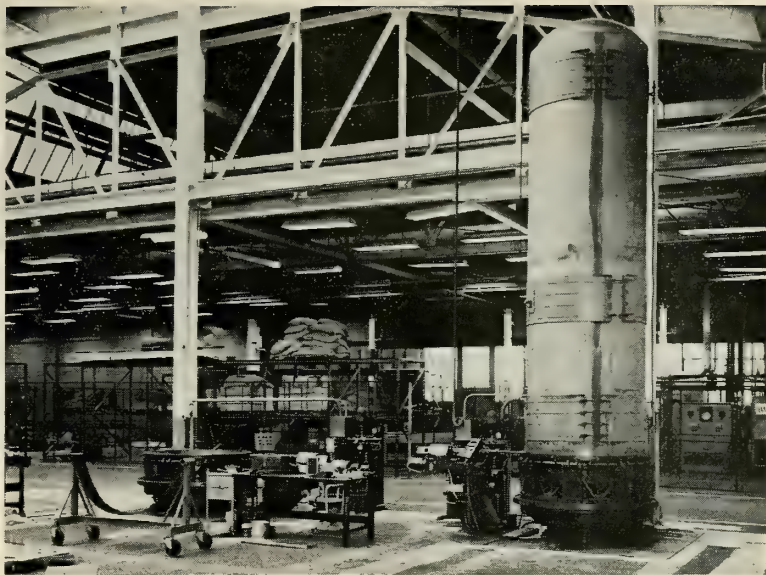
The furnace has a controlled atmosphere—currently Thermalene gas. The pit furnaces can also incorporate controlled atmosphere operations. In case-treating the quenching rate must be carefully controlled to avoid out-of-roundness. Each case is measured for this defect after high heat and then fully fixtured stress-relieved.

Again the case is checked for roundness.

• **Machining hardened cases**—The threading operation takes place after the heat-treat when the case and aft closure is in the hard condition. This GE innovation is spreading to other manufacturers. All finish-machining on the case is performed in the Merz thread-machine fixture. This excludes one drilling operation.

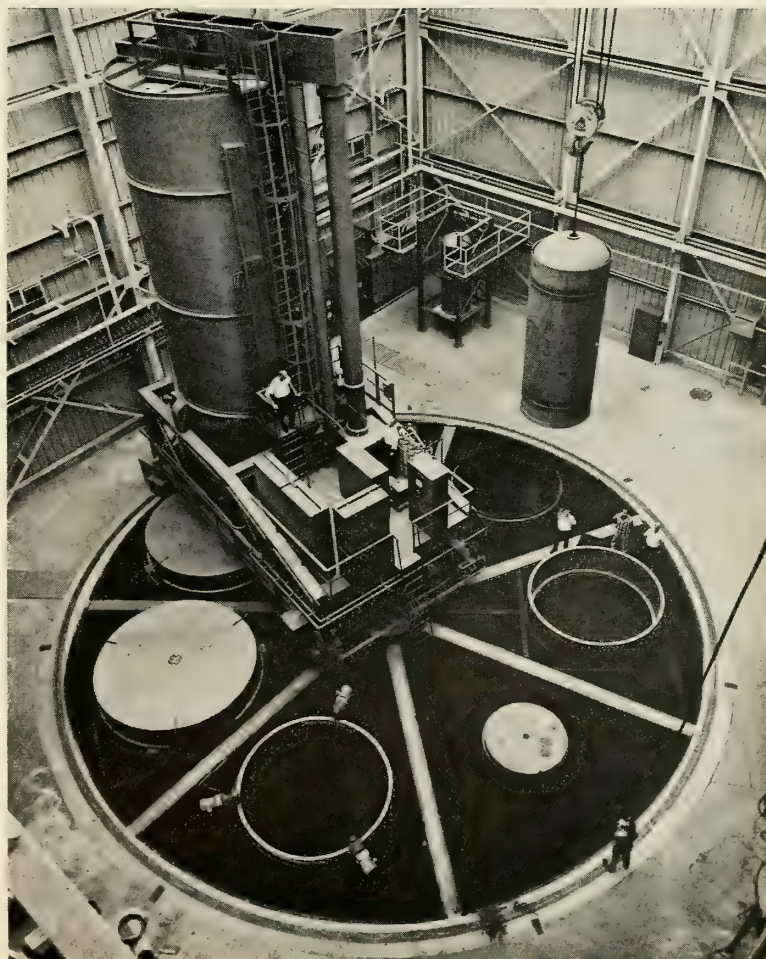
The aft closure is buried in epoxy on its fixture for threading and facing. The piece is then mated to the case. GE is purchasing a new machine from Merz to increase capacity. At the same time, the unit is being uprated to allow only one fixture for the aft closure.

missiles and rockets, September 11, 1961

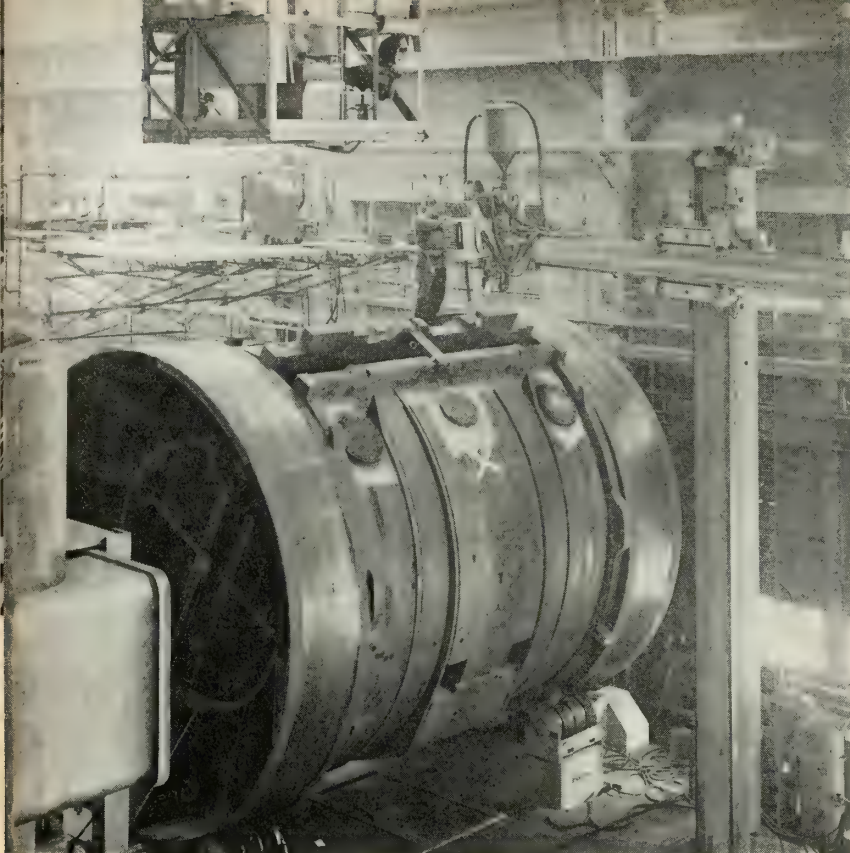


**ABOVE:** Vertical fixture drills circumferential skirt holes automatically. Completed unit is Magnafluxed and X-rayed, then hydrotested with oil.

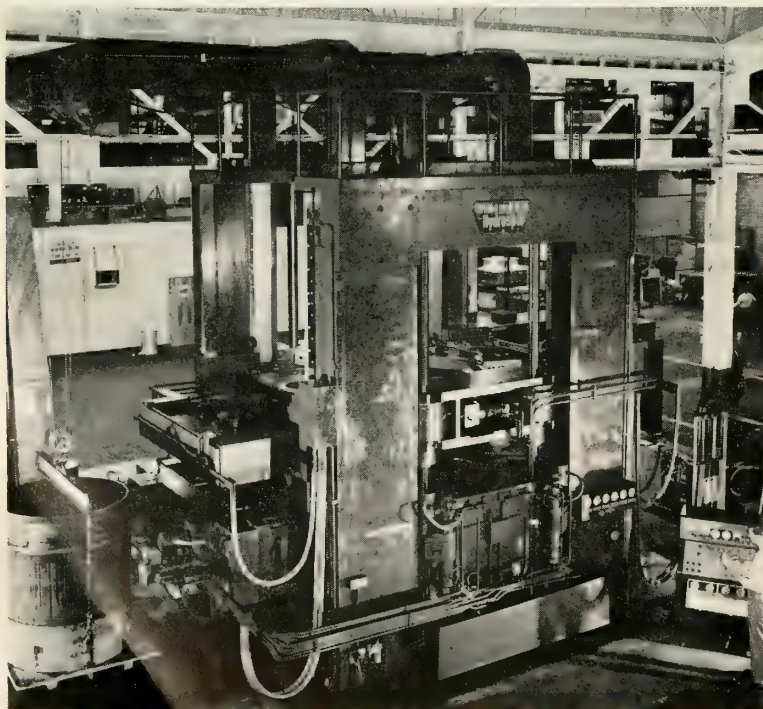
**BELOW:** Huge heat-treating furnace built by GE specifically for motor cases is currently strengthening the 120-in. Grand Central Rocket chamber.







*WELDING FIXTURES* such as this could be adapted to joining of pressure-vessel components without the tremendous expense involved in completely new facilities.



*CINCINNATI HYDROSPIN* has an overall height of 38 ft., sunk 17 ft. into the floor. The unit can roll-form a complete Minuteman case center section.

GE drills the skirt holes with the case in a vertical position. The completed unit is Magnafluxed and X-rayed then hydrotested with oil. A second final inspection takes place and the chamber is shipped to Thiokol Chemical Corp., propulsion prime contractor for first-stage *Minuteman*.

While the machines and tooling in the *Minuteman* case program at GE are impressive, the key to operationally perfect chambers lies in the manufacturing personnel and the extreme care taken with each step. In the welding operation alone, the operator has a multi-page check list which requires him to perform over 60 different tasks—some of which are not connected with the actual welding operation.

Wettach says the basic theme is to take a standard operation and carry it to the ultimate degree of perfection. In the welding sequence, some of the requisite actions include vacuum cleaning the floor area, shutting down certain air circulating equipment and additional drying of the welding gas. Odd little things, like finding it better to eliminate the grinding wheel in weld preparation and using only carbide burr tooling have been picked up along the way.

Even the welding stock is hermetically sealed and opened just prior to use. Excess after one operation is not used in the next. The stock is carefully kept clean—even a fingerprint could result in a defective weld.

The same procedure led GE to perfect a method of tapping a closed hole in Rockwell 52 steel—a task termed "impossible" but accomplished with standard equipment by exact control over every conceivable variable.

• **Tight little island**—Another striking transition from traditional manufacturing is the foreman setup in the rocket-case section. The men performing the actual work are under close supervision by graduate engineers fulfilling all the tasks normally handled by foremen. These engineers are chosen for technical competence and ability to work with the men on the floor.

This tight organization is extremely responsive to management and they, in turn, have learned to respond quickly to customer needs.

Wettach says the missile case business is much more competitive than the jet engine market. He has found elaborate "sell" methods uneconomical. The small group of customers buy on quality, reliability and price. The last item is becoming more and more important as the technology and competition improves. GE is working PERT into its case operations and much of its proposed large chamber work will be keyed to this management system.



# Soviet Efforts Are Closely Watched

by William Beller

SOVIET PHYSICISTS are vigorously pushing gravity research—and publicly lamenting their “uncertainty and frustration.”

Any advance in understanding gravity—long overdue compared with recent breakthroughs in other branches of physics, such as subatomic physics and field theory—could give enormous advantages to its discoverers.

Consequently, the Soviet work warrants the “closest continued watchfulness.”

These are the chief findings handed to the Air Force's Aerospace Technical Intelligence Center—now the Foreign Technical Division—by the Library of Congress' Science and Technology Section last October. The study was made by Garbell Research Foundation of San Francisco. Intelligence sources say that the picture is still the same today.

The study of Soviet hypotheses and reports on gravitation indicates that all serious scientific thinking published in the Soviet Union is rooted in the fundamental theories developed in the West. Einstein's theory is characterized as “the best existing theory,” or at least as “the predominant theory” of gravitation.

During the 1957 winter and the following spring, Dr. Kirill P. Stanyukovich, mathematics professor at the Moscow Higher Technical School spoke of “forthcoming advances” in Soviet ability to overcome the pull of gravity on aircraft and space vehicles. These predictions by a leading Soviet scientist admittedly sparked the Air Force-sponsored study.

• **Mass without weight**—If statements about gravity had been made by a lesser light than Stanyukovich, they probably would have been ignored by our military. However, Stanyukovich is a member of the Interplanetary Flight Commission of the Soviet Academy of Sciences, a top-ranking scientific and policy-making organization. Moreover, he is widely recognized as a brilliant mathematician and physicist, and a specialist in gas dynamics and fluid dynamics.

Some of his work—whose publication has been sponsored by Academician N. N. Bogolyubov, the eminent Stalin-prize-winning mathematician and

physicist—has appeared in the Academy's journal. Furthermore, Stanyukovich has co-authored several important scientific papers with Academician I. D. Landau, another internationally-known Soviet physicist.

Here's the essence of some of Stanyukovich's recent remarks about gravity:

—He broaches the possibility of a “graviplane,” a machine not subject to gravitational forces.

—He theorizes that “lowering the temperature of matter to absolute zero would lead to a considerable decrease in gravitational forces and possibly their disappearance,” thereby creating “weightless matter.”

—He envisions “weightless matter” being used to build aircraft and space vehicles.

—He has constructed a theory in which the gravitational field of ponderable masses is caused by superhigh-frequency (multi-billion-cps) vibrations of matter and by the ejection—from the vibrating body—of energy in the form of gravitational quanta or “gravitons.” Stanyukovich states that this gravitational radiation “would be more intense at high temperatures and, conversely, reduced virtually to zero at low temperatures, near absolute zero.

—He predicts the use of antimatter (matter made up of antiprotons and positrons instead of protons and electrons as in ordinary matter) to overcome gravitation.

• **There are disbelievers**—These are all observations that can readily find their duplicate in science-fiction writings. Yet they were enunciated by a respected scientist and investigated by a U.S. intelligence agency.

The study made for the Air Force points out that “Although authoritative Soviet physicists delineate the current status of Soviet research on gravitation with a measure of uncertainty and frustration, their efforts, like those of their Western colleagues, are so intense and unflagging that they warrant the closest continued watchfulness.”

Stanyukovich's assertions are receiving no public support from his colleagues, and are scorned by at least one renowned Soviet physicist, D. D. Ivanenko.

Soviet-area physicists have proposed

widely different theories on gravitation, and the Air Force intelligence report narrows them down to the following three:

Some scientists, such as L. Infeld (Poland), regard gravitation as a purely geometric phenomenon which does not comprise any radiational transfer of energy between bodies; hence, there is nothing in the gravitation field that man can modify.

Other scientists, such as V. A. Fok and D. D. Ivanenko (USSR), believe there are energy-carrying “gravitational waves” which can be quantized into energy quanta, hypothetically named “gravitons.” However, these men consider the amount of energy transported to be so small as to be a wholly negligible aspect of gravitation. Thus, even a total elimination of gravitational-wave quanta or “graviton transmutation” could not effect an annihilation of gravitation.

There are also Stanyukovich's views, with which he stands almost alone, at least publicly.

• **Feet of clay**—The gravitational force, which is the oldest known to man and the first one theoretically distinguished, still suffers observationally. In fact, over the past half century there has been practically no fundamental work done on gravitation.

In addition, aside from the theoretical papers by Einstein and his associates, “there is no single major theory or scientific hypothesis on gravitation on which agreement of a substantial majority of theoretical physicists can be found,” according to the Air Force report.

The study also sadly relates that “The prevailing disagreements appear indelible and unyielding, so long as no experimental proof can be adduced to establish at least some points of common acceptance.”

(This 389-page study has recently been released through the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. It costs \$5.)

Whatever the reason for the lag in experimental gravitational work, Princeton University physicist R. H. Dicke says it “has resulted in one of the most beautiful theoretical edifices of physics resting upon a very weak observational foundation.”



# Practical Anti-Gravity Still Far Off

*Theoretically feasible ways to counteract earth's pull abound, but machines require new materials and advanced theories*

by Robert L. Forward

**GRAVITY GLOSSARY**—Below is a list of key terms involved in discussions of gravity, with their definitions.

**GENERAL RELATIVITY**—A theory of gravitation. Presently accepted as the best theory of gravity, but there are only a few experimental verifications. Distinct from SPECIAL RELATIVITY.

**SPECIAL RELATIVITY**—A theory of velocities. Used every day in atomic research. Distinct from GENERAL RELATIVITY.

**ACTIVE GRAVITATIONAL MASS**—That property of a body which gives rise to a gravitational field. Probably identical with PASSIVE GRAVITATIONAL MASS and INERTIAL MASS.

**PASSIVE GRAVITATIONAL MASS**—That property of a body which is affected by an applied gravitational field. Probably identical with ACTIVE GRAVITATIONAL MASS and INERTIAL MASS.

**INERTIAL MASS**—That property of a body which determines the resulting acceleration for a given force. Probably identical with ACTIVE and PASSIVE GRAVITATIONAL MASS.

**ANTI-GRAVITY**—A confusing term since there are at least five different ways conceivable to counteract gravitational fields. (See LEVITATION, SHIELDING, NEGATIVE MASS, GRAVITY

GENERATION, NULLIFICATION.)

THERE'S LITTLE TROUBLE predicting anti-gravity from Einstein's theory of gravity. Nor is it a problem to conceive anti-gravity devices, at least in theory.

But, unless there are major breakthroughs in both theories and materials, a practical anti-gravity device is a long way from realization.

There are many well-known solutions to Einstein's theory of gravity which show that the gravitational force exerted by a body depends not only upon the mass of the body but also on its motion.

Because of these gravitational effects due to rotating or accelerated masses, it is possible, in theory, to construct a device that will create a gravitational field in any direction. By generating this field in an upward direction at some spot on the earth, we could theoretically counteract the earth's gravitational field.

Unfortunately, the calculated effects are very small if we assume presently available materials and energies. Unless

a major breakthrough is made along these lines, it is probable that practical anti-gravity will be technologically impossible for a long time.

**Einstein's theory**—All of the advanced research into gravitation has been in theoretical studies using Einstein's General Theory of Relativity. The very compact and logical structure of Einstein's theory suggests that there is no mathematical difference between the effect of a gravitational field and the effect of a curved space.

From this point of view, static and moving masses do not create gravitational fields but instead cause the space around them to be curved. There instead of having bodies moving under the influence of gravitational forces in a flat space, we have bodies with no gravitational forces on them moving in a curved space.

This concept has a great deal in its favor because the mathematical equations and logic are immediately simplified by many orders. However, this

the ACTIVE GRAVITATIONAL

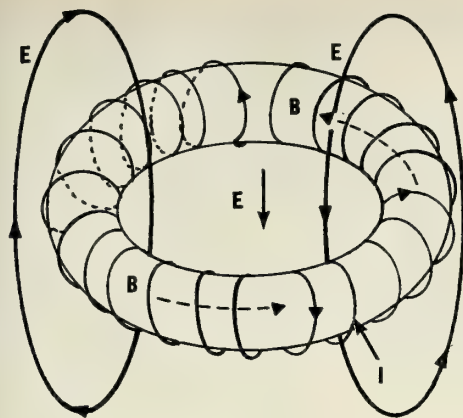
MASS of a body or the gravitational constant so that the gravitational field of the earth could just be "turned off."

**GRAVITATIONAL WAVES**—Time-varying waves of gravitational energy, quite similar to electromagnetic waves. Einstein's GENERAL RELATIVITY equations for gravitation reduce to a wave equation with velocity  $c$  when linearized.

**DWARF STARS**—Dying, collapsed stars with densities about  $10^{10}$  gm/cc. They average about one in 100 stars. Such super-dense material would be valuable for gravitational experimentation.

**ANTI-MATTER**—Matter made from positrons, anti-protons and anti-neutrons which have an opposite charge and magnetic field from their "normal" counterparts. Anti-particles and normal particles are formed in pairs from gamma rays. From the EÖTVÖS EXPERIMENTS it is known that positrons have identical INERTIAL MASS and PASSIVE GRAVITATIONAL MASS.

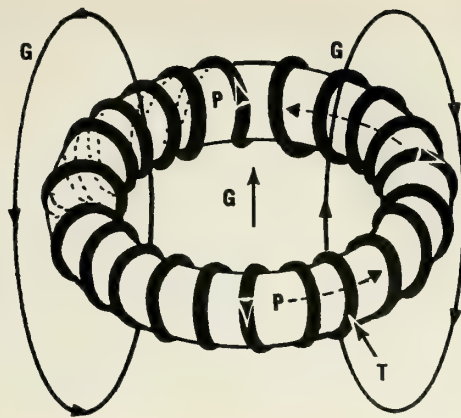
**EÖTVÖS EXPERIMENTS**—Experiment which showed that INERTIAL MASS and PASSIVE GRAVITATIONAL



$$E = -\dot{B}$$

$$= -\frac{\mu_0}{4\pi} \frac{N \dot{I} r^2}{R^2}$$

**1A**



$$G = -\dot{K}$$

$$= -\frac{\eta_0}{4\pi} \frac{N \dot{T} r^2}{R^2}$$

**1B**

formalism—which combines gravitation, space and time into one compact and logically simple form—has the unfortunate property of completely obscuring things from a practical point of view.

There is another formalism in which Einstein's theory may be presented—one which, in many ways closely corresponds to the formalism of electro-magnetic theory. For every field and force in electromagnetic theory, there is

a corresponding gravitation field and force. In addition, there are other gravitational effects which have no counterpart in electromagnetic theory.

For instance, the one analogy that we all know about is that the gravitational field of a static mass corresponds to the electric field of a static charge. The equations are the same and the only differences are that two particles with the same type of charge repel, whereas two particles with the same type of mass attract.

• **A new gravitational field**—Besides this well-known analogy, there also exists a gravitational equivalent to the magnetic field. This field arises from the effects of moving or rotating masses. It obeys the same form of equations as the magnetic field; all the things that can be done with a magnetic field can be done in an analogous manner with this field.

For instance, if a massive particle moves through this gravitational equivalent to the magnetic field, then it experiences a gravitation-like force; but the force on the particle is at right angles to both its direction of motion and the direction of the field.

By a gravitation-like force, we mean that the accelerations given to the test body by this force are independent of the mass of the test body, and therefore are indistinguishable from gravity. Because gravitation-like forces act independently on each atom of the body at the same time and with the same acceleration, there are no internal stresses in the body and very large accelerations can be tolerated.

It is because of this possibility of using very high accelerations in space

vehicles without any stresses being exerted on the occupants that makes gravitational methods of propulsion very attractive.

Other conceivable effects of this field include the following: Two pipes with a massive liquid flowing rapidly through them will repel each other due to the gravitational equivalent of the "pinch effect," and two massive rotating gyroscopes will repel each other if properly oriented. None of these predicted effects have been seen and when we put numbers into the equations, we can see why—the effects are very small if we use presently available material and energy sources.

• **Anti-Gravity**—It is also, in theory, possible to build a machine to create a field that will exert a gravitation-like force in any direction, on any ordinary, non-rotating, non-moving mass such as a person. Thus, by generating this field in an upward direction at some spot on the earth, we could theoretically counteract the earth's gravitational field.

These and other non-Newtonian gravitational forces have been calculated for a number of specific models; equations describing these forces are available in texts such as C. Moller, *The Theory of Relativity*, page 319, and J. Weber, *General Relativity and Gravitation Waves*, page 160. The calculated effects are very small.

An example of such an anti-gravity machine, readily visualized by its analogy to electromagnetism, is a system of accelerated masses whose flow can be approximated by the current flow in a wire-wound torus or ring.

(Continued on page 45)

MASS are identical to 1 part in  $10^8$  for all substances tested. Indirectly this also shows that the two masses are the same to 1 part in  $10^5$  for energy such as gamma rays and 1 part in  $10^2$  for positions. (See ANTI-MATTER)

**NEWTONIAN GRAVITATIONAL FIELD**—A field generated by all bodies whose strength is proportional to the ACTIVE GRAVITATIONAL MASS ( $M_a$ ) of the body. The field will exert a force on other bodies whose strength is proportional to the PASSIVE GRAVITATIONAL MASS ( $m_p$ ) of the affected body. The force will cause an acceleration ( $a$ ) of the affected body inversely proportional to the INERTIAL MASS ( $m_i$ ) of the affected body.

$$m_i a = -\frac{GM_a m_p}{r^2}$$

There is strong experimental evidence that there is no difference between the three possible types of mass (See OTVOS EXPERIMENTS)

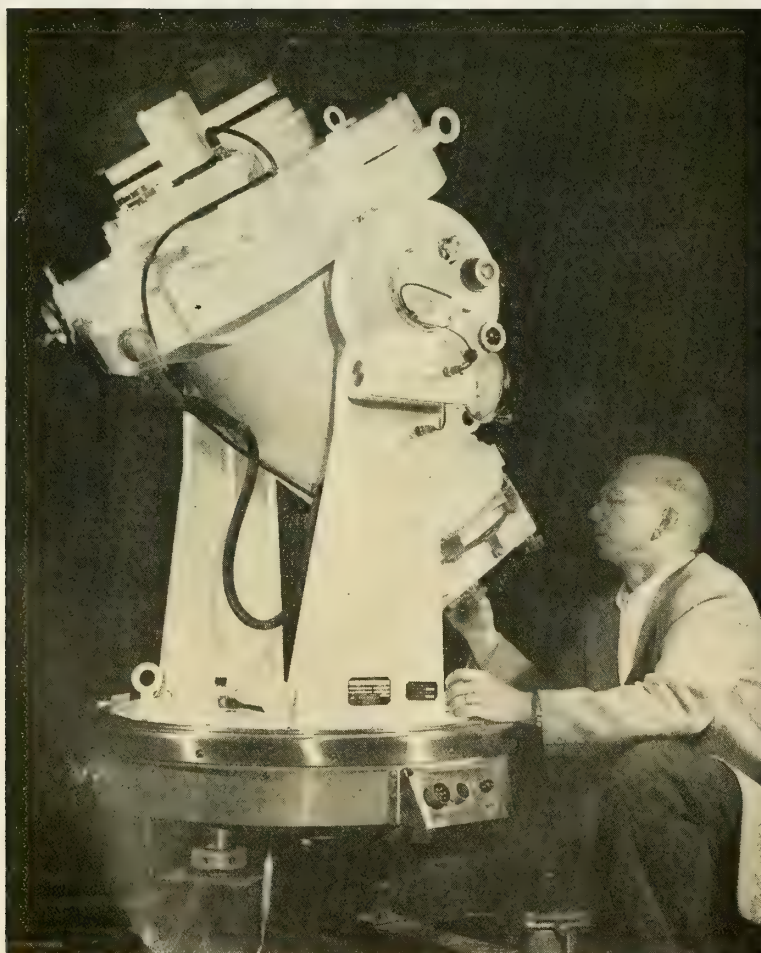
**GRAVITATIONAL FORCE**—A force exerted on the volume of a body which results in an acceleration independent of the INERTIAL MASS of the body, and is therefore indistinguishable from gravity in a local region.



# AMR Buys Biggest Ballistic Camera

**Nortronics-built units, weighing 1660 lbs. and four feet tall, are first of type ever produced in America and are expected to spot missiles within 26 ft. at 1000 miles**

by Charles D. LaFond



**1660-LB. BALLISTIC CAMERA**, developed by Nortronics for the Air Force, is one of six to be in operation soon on Atlantic Missile Range. The 600-mm F/2.0 system will be used to determine trajectories with accuracy of 1 part in 200,000.

ANAHEIM, CALIF.—The world's biggest known ballistic camera soon will be put to work at the Atlantic Missile Range.

Designed as the penultimate in accuracy for gathering optical data during missile flight tests, the nearly 1700-pound camera is believed capable of linear and angular accuracies to 1 part in 200,000.

Built here by Nortronics Division of Northrop Corp. for the Air Force, the 600 mm F/2.0 ballistic camera is expected to be able to locate a missile within 26 ft. at a distance of 1000 miles, developers say.

First tests, using star images only, will begin this month. Following acceptance, one will be installed at a site in Vero Beach, Fla. The other five will be located on islands downrange; specific sites have not yet been announced.

Contract value to date for development and delivery of the six ballistic cameras is \$1 million.

First of its type ever built in the U.S., the camera has many unique design features, including an ultrafast-louvre-type shutter assembly for a 12-in. camera aperture. Its 240-lb. lens configuration required development of a new lens-mounting technique to minimize strain within each of the eight oversize optical elements—the largest being nearly 15 in. in diameter.

• **Star background**—The 4-ft.-high ballistic cameras will be installed at several sites throughout the AMR to augment a network of 300 mm aerial mapping cameras now used to record missile flights. The sites, currently employing the Wild Heerbrugg, Ltd., BC-4 ballistic camera, are being modified for installation of the new system.

The ballistic camera is used to determine nearly exact missile trajectory by photographing its flight against a star background. Before launch, the star field is photographed. During the flight, the camera records images of precisely timed strobe-light flashes. Then another star trace is obtained.

Image location of the strobe light is later compared with the star images whose positions are very accurately known to determine angular position of the missile. Multiple-site triangulation techniques are employed to find

missile height with respect to time.

Nortronics designers believe that with proper geometry, linear measurement can be made as accurate as angular measurement.

Under the present contract, six cameras will be delivered to AMTC in Florida. Besides their use in determining missile trajectories, the cameras will be used to obtain position data on orbiting satellites. Because of their unusual accuracy, units will be employed in calibrating electronic tracking instruments and for conducting geodetic surveys.

• **Easily synchronized** — The Nortronics-designed camera is a 1660-lb. fixed instrument having a very fast, almost distortion free, lens system of 600 mm focal length. The shutter assembly is solenoid actuated with open and close pulses generated externally. The iris is electrically controlled remotely and the diaphragm is driven by an integral motor.

Overall design of the system permits installation in almost any location from hardened missile sites to ships. Size and weight of the camera's cast-iron mount provide good static stability and a remote electrical control assists dynamic stability. Excluding the mount, the camera measures 43 in. long and over 29 in. diameter.

The camera is manually oriented; fine adjustments are made through worm gears. It can be locked firmly into position in each axis by clamps. The mount can be leveled to 5 sec. of arc.

Scales on the camera mount for azimuth and elevation location are graduated to 30 sec. of arc. For alignment, an 8-power sighting telescope having an 8 degree field is used. The scope is attached to the upper (elevation) trunnion of the mount.

Azimuth range is a full 360 degrees; elevation from -3 to +95 degrees.

Camera back design follows that of the Wild BC-4. It will accept and use the same plate holder used in the BC-4. The plate holder can be removed easily with the camera in any position.

The shutter pulsing permits use of several cameras for exact sequential exposure along a ballistic path. Cameras can be synchronized easily, developers say, to within 1 millisecond.

Operating cycles can be varied from 10 milliseconds to 2 seconds for synchronized operation.

The shutter opens or closes in 2 milliseconds and it can be programmed to remain open for any length of time.

• **Computer - designed lenses** — A Bendix G-15D computer with plotter attachments was used extensively by Nortronics optical specialists in designing the camera lens system. Through

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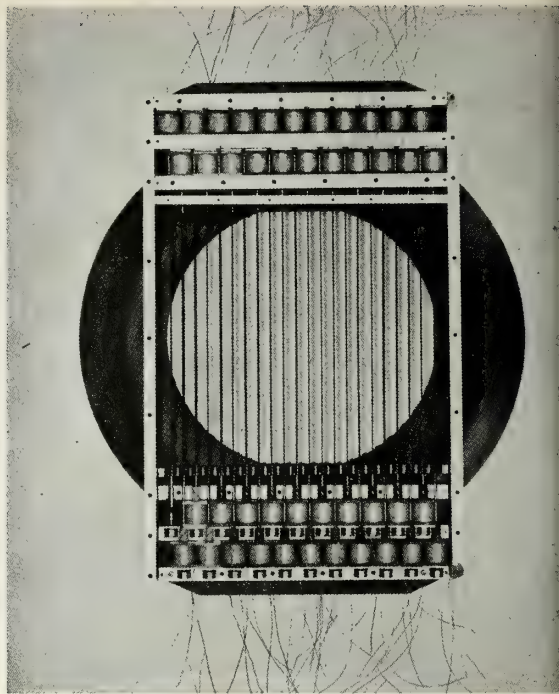
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**LOUVRE-TYPE** shutter assembly is solenoid-actuated. A between-the-lens type, it is located between the second and third elements of the lens system. This is a front view, blades open.



**ARMCO STEEL** shaft on each of 22 blades of shutter assembly serves as core of actuating solenoids. Pinned cores ride in cam-slot of solenoid spools to turn blades 90 degrees.

its use, said one scientist, the total design period was greatly reduced.

For example, it was capable of tracing a light ray through a single surface in less than 2 seconds. Thus, spherical aberration of the system could be determined in well under 1 minute.

After computation, computer and plotter were used for automatically making spot diagrams at a rate of 100 spots per minute. The plotter also was employed for rapid sketching of the optical system. This, he said, was extremely useful in checking center thicknesses, diameters and clearance.

In the original lens system design, nine elements were to be employed. Later, one element was eliminated when the computer showed the change would have no degrading effect on either quality or performance of the camera.

• **Special glass needed**—To obtain the required refractive index and dispersion characteristics, it was necessary to use a special rare-earth glass for elements 1 and 2 in the lens system.

All lens blanks for the system are being manufactured by Hayward Scientific Glass Corp. The rare-earth elements, according to the company, are the largest such blanks ever cast. Designated RE-10, these front elements are made from lanthanum oxide.

To minimize formation of gas bubbles in the blanks, the elements were

cast in crucibles fitted with a platinum liner.

Elements 4, 6, 7 and 8 are of dense barium crown glass. Element 3 is extra-dense flint; element 5 is a dense flint.

Because of the great size of all elements and the impossibility of maintaining tight index-of-refraction tolerances, final design of each of the other six lenses was determined only after receiving blanks for all eight elements and analyzing their optical properties.

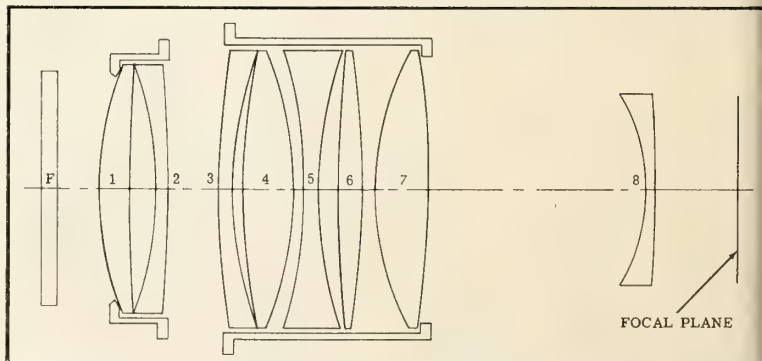
With time, Nortronics developers believe, the front two elements might eventually be made from more conventional glass, rather than the hard-to-

obtain RE-10.

• **New potting technique**—Problems were encountered by the developers in lens mounting. Design requirements demanded that the lens assemblies be tested completed over the temperature range from -30 to 190 degrees F and through moderate vibration and rough handling.

It was determined to put lenses within mating steel rims. The clamping rings were soldered to make the assembly rigid.

Lenses were then centered within a cylindrical mount to within 0.0002 in. and each rim was soldered to the cell



**EIGHT-ELEMENT LENS SYSTEM** as used in final design of new ballistic camera. The system, developers say, has less than 25 microns of radial distortion and less than 5 microns of tangential distortion.



**LENS CELL** is centered in the main lens frame for soldering. A reticle in the element center is sighted for alignment. Setscrews about main frame secure cell for soldering.



**TECHNICIAN CENTERS** a reticle on lens element. Lens, set on three ball bearings, is rotated to find center of top and bottom surfaces. Reticle will be replaced with wax on top.

Strain was constantly observed in the glass with polarized light and indicators were used to detect element movement.

A hard polyester resin was first used, but under severe temperature tests cracks developed running from the resin into the glass edge to about 1/16 in.

A soft rubbery compound was found that was both hard enough to support the lens and soft enough to allow for the differential contractions of steel and glass at low temperatures. This approach met all stability requirements, developers said.

• **Shutter actuating system** — The shutter assembly employs 22 blades, 0.60 in. wide. An Armco steel shaft attached to each end of each blade serves as the core for each of the actuating solenoids. The solenoids are copper wound spools of molded nylon (molydisulphide impregnated nylon) having an integral helical slot serving as a cam. A pin in each of the steel cores rides in the solenoid slots.

When the solenoid is energized, the core is pulled into the solenoid and the helical cam slot forces the blade to rotate through 90°. Inner row solenoids close the shutter; outer rows open it. To cancel out inertial forces, cams on every other blade are opposite hand.

Deceleration bumpers soften the stopping action after the blades have been energized. The cam-pin design and

the fact that the blade is in tension during actuation minimize problems of blade whip and twist.

A single blade mockup has been life tested to over 350,000 cycles before failure. An improvement in blade design has apparently eliminated the failure cause.

• **Shutter control circuitry** — Circuitry is synchronized with the 24-v square-wave command pulse now used to actuate the capping shutter of the Wild BC-4 ballistic camera. The 10  $\mu$ sec. rise time of leading edge of this 24-v pulse is used to construct opening trigger pulse for the shutter by feeding the pulse into a pulse transformer.

Closing trigger pulse is from trailing edge or fall time of the command pulse. Negative transients are eliminated by directing pulses through two diodes. Two clean positive pulses are the result.

Two distinct but identical circuits are used to operate the shutter system — one for opening, one for closing. Power source for each is a high current toroid power transformer. Primary input is 115-v, 60-cycle, 25-ampere.

A charged bank of capacitors connected across a silicon diode control operates the shutter assembly solenoid coils on discharge. Complete recharge requires 0.3 sec.

Repetition rates in a test assembly are variable from 1-13 exposures/sec. and exposure time can be controlled

from 3-60 milliseconds.

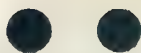
• **Optical problems** — Secondary spectrum and other residual color aberrations with this system are quite significant because of the long focal length and large relative aperture employed in the camera design.

This is true of any 600 mm F2.0 system. Further, Nortronic scientists assert that secondary spectrum cannot be effectively reduced without limiting other performance requirements demanded of the ballistic camera lens. (The only configuration totally free of secondary color is a mirror system, which would not meet ballistic camera requirements.)

The effect of secondary chromatic aberrations is that the lens has some of the properties of a narrow bandpass filter. In addition, light not used in image formation is scattered over the film plane. In a proper filter it would be absorbed.

As a result of an extended study of the on-axis imagery characteristics of the 600-mm F/2.0 optical system, Nortronics determined that Class O or Class J emulsions would provide the best image recording results. The par-chromatic characteristics of Class F emulsions proved to be detrimental to obtaining good images, although use of a 44-A filter would provide comparable results to that of the recommended film types. ❖





RAIN



HAIL



THUNDER



LIGHTNING



ICE PELLETS, SLEET



HIGH DRIFTING SNOW

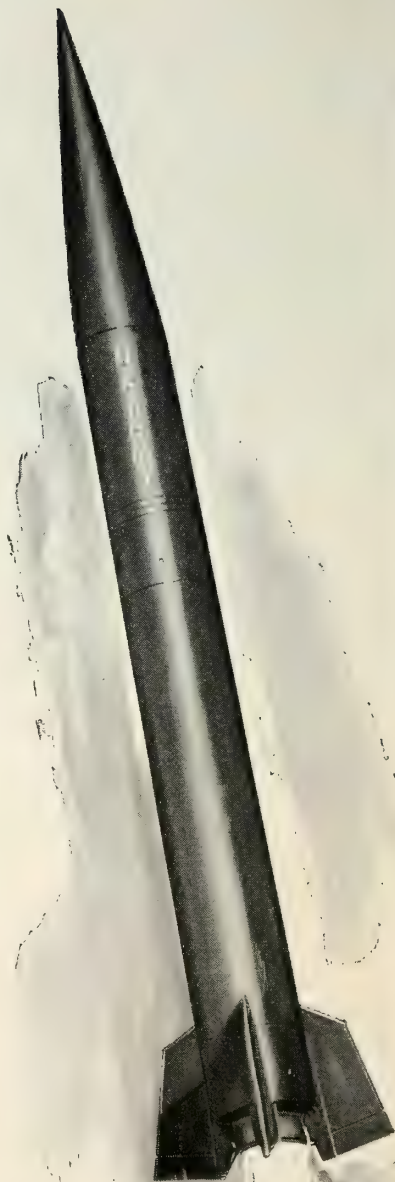
## weather bird

Rain (••) hail (A) thunder (K) lightning (Z) ice pellets, sleet (\*) high drifting snow (+) are merely symbols on a weather map—not expected to be problems to the U. S. Army's SERGEANT missile system.

SERGEANT missile system's objectives are to be ready for action in the meanest weather, the most extreme temperatures and environments, at high and low altitudes. It can be checked out by one man with minimum training, emplaced and fired in a very short time by a six-man crew.

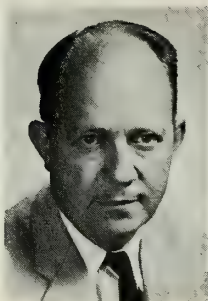
The land, sea and air-transportable SERGEANT system, produced for the Army by Sperry Utah—when it becomes operational—will take its place among the tough and dependable sergeants of U. S. Army tradition.

**SPERRY**





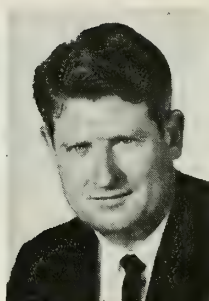
**SALINE**



**SANDBERG**



**STEELE**



**BRYAN**



**TANGEMAN**

**Col. Jack D. Koser (USAF-ret.) and Lt. Col. J. A. Ogle (USA-ret.):** Join the staff of the director of long-range military planning, The Bendix Corp., Detroit, responsible primarily for long-range planning in their respective areas of interest. Koser formerly was chief of the advanced analysis branch of the Directorate of Development Planning, the Pentagon. Ogle's most recent assignment was a general staff officer with the Army General Staff, serving as project officer for the *Jupiter* and *Pershing* missiles, and as deputy chief, Missiles and Space Div., in the office of the chief of Research and Development.

**R. E. Whiffen:** With Bendix since 1946, appointed general manager of Bendix-Products-Aircraft Division, South Bend, Ind.

**Charles E. Heitman, Jr.:** A vice president and member of Bendix Corp.'s administration committee, assigned new executive responsibilities for the corp.'s Cleveland Instrument Co., Micrometrical Mfg. Co., and the Industrial Controls Section.

**Joseph R. Carter and Sacket R. Duryee:** Appointed directors of Wyman-Gordon Co., Worcester, Mass.

**Charles F. McMorrow:** Formerly with RCA, joins the General Mills Electronics Group, Minneapolis, as associate director for engineering in the Research and Development Department.

**Dr. Edward B. Evans:** Appointed research metallurgist with TAPCO, a division of Thompson Ramo Wooldridge, Inc., Cleveland. Evans formerly held an assistant professorship in metallurgy at Case Institute of Technology.

**Walter J. Koshuba:** Formerly with GE's Aircraft Nuclear Propulsion Div., joins The Beryllium Corp. as plant manager of the Nuclear Division, Hazleton, Pa. **Philip H. Snyder** promoted to plant manager of the Alloy Div., Reading, Pa.

**Dr. Arthur D. Kirsch:** Appointed director of a newly-created Life Sciences Div., Datatrol Corp., Silver Spring, Md. A prime aim of the new division will be to conduct research in areas where it is

feasible to apply computer technology, with particular emphasis on the life and social sciences.

**Raymond H. Herzog and Harry Heltzer:** Elected vice presidents, Minnesota Mining & Manufacturing Co., St. Paul. **E. J. Kane, A. H. Redpath and R. W. Adam** elected divisional vice presidents.

**Lawrence B. Miller:** Promoted to manager-manufacturing administration and plant facilities for General Electric's Industry Control Dept., Salem, Va. **Dr. Lindon E. Saline** appointed manager of Specialty Devices Operation of GE's Defense Systems Dept., Syracuse, N.Y.

**Dr. K. O. William Sandberg:** Named assistant to **William M. Smith**, vice president and manager of Aerospace-Rockets Division, Textron's Bell Aerosystems Co., Buffalo, N.Y. Dr. Sandberg formerly was executive vice president and general manager, Norton Laboratories, Inc. **Charles H. Kenerson** named director of marketing of the Aerospace-Rockets Division.

**Henry A. Samulon:** Named associate director of Electronics Div., Space Technology Laboratories, Inc., Los Angeles. **Dr. Joseph F. Shea** succeeds Samulon as director of the technical team heading STL participation in the *Bambi* program.

**Donald B. West** appointed to newly-created position of associate head, Antenna and Microwave Section, STL's Communications Laboratory.

**Dr. Theodore K. Steele:** Named executive vice president of Bulova Research & Development Laboratories Division of Bulova Watch Co., Inc., Woodside, N.Y. Dr. Steele succeeds **Mell A. Peterson**, recently appointed special assistant to **Kenneth E. Fields**, company executive vice president for non-consumer product activities.

**Lt. Col. Martin L. Raines:** Appointed chief of the U.S. Army Rocket and Guided Missile Agency's Pacific Field Office on Kwajalein Island.

**James W. Bryan:** Promoted to West

Coast area manager, Beech Aircraft Corp.'s Aerospace Div., Los Angeles. **G. R. Miller** named manager, San Diego area.

**Gerald A. Tangeman:** Elected assistant secretary and assistant treasurer, United Electronics Co., Newark, N.J., a subsidiary of Ling-Temco-Vought, Inc. Tangeman succeeds **Douglas C. Bevins**, who has retired.

**Bruce F. Powers and Howard L. Wiener:** Join the Washington, D.C. research staff of the Operations Evaluation Group (OEG), part of the Division of Sponsored Research, Massachusetts Institute of Technology.

**John J. Connolly:** Named vice president and general manager, Data Systems Div., Litton Industries, Inc., Los Angeles. **W. Dewey Clower** named applications engineer, Millimeter Wave Tubes, Electron Tube Div., Litton's Washington, D.C., office.

**Brooks T. Morris:** Appointed special assistant for reliability assurance, California Tech's Jet Propulsion Laboratory, Pasadena. Morris formerly was director of the Propulsion Div., The Marquardt Corp., in charge of missile engine development.

**Lt. Col. Russell W. Ernst, USA:** Named acting chief of the technical and industrial liaison office of the Office of the Chief of Research and Development in the Pentagon. Col. Ernst succeeds **Col. Jackson E. Shirley** of the Army General Staff, who retired recently after 21 years of service.

**Ralph E. Rhoads:** Former general counsel for Servomechanisms, Inc., joins Radio Corporation of America's West Coast Missile and Surface Radar Division, Van Nuys, as manager, contracts administration and marketing services.

**Robert C. Lockwood:** Formerly in charge of planning of development programs, named executive vice president of Instruments for Industry, Inc., Hicksville, N.Y. Lockwood also is a director of the company.



# Lockheed Backing Gives GCR Boost in Lunar Contest

THE RACE for the lunar solid-booster contract is taking on a new complexion with Lockheed Aircraft Corp.'s complete acquisition of Grand Central Rocket.

GCR—with Lockheed's resources, management and sales know-how behind it—may now move from a "dark horse" position into top contention. The move is encouraging GCR officials to hope for a major slice of the big booster work.

Lockheed President Courtland S. Gross, in announcing the cash purchase (the amount was not disclosed), said last week it was a "logical step."

While it was obvious that GCR will give Lockheed an all-around capability, there was no indication how the acquisition will fit specifically into Lockheed's corporate plans. Timing of the move, however, seems to dovetail pretty much with NASA's *Apollo* program, which is still in the process of getting off the ground. Major contractors for both propulsion and the spacecraft are not expected to be selected until the first of the year.

Lockheed acquired a 50% interest in the Redlands, Calif., firm last year.

The agreement completing ownership was worked out with Petro-Tex Chemical Corp., which is owned jointly by FMC Corp. and the Tennessee Gas Transmission Co. Grand Central had sales of \$9.5 million last year.

Gross said GCR will operate as a division with Burt C. Monesmith, corporate vice president of manufacturing, as president and general manager. Dr. Cleo Brunetti, who had headed GCR, resigned earlier this summer to take another post in industry. The chairman of GCR is Maj. Gen. John W. Sessums, who retired as vice commander of ARDC (now Air Force Systems Command) in 1960.

Officials connected with the company indicated that there would be "no serious management changes."

GCR recently reported the purchase of a large desert area for a big booster development and test area. Some industry observers have noted that the company had seemed to have its future tied to one product—big solids—and if it failed to get some of this business it would be in real difficulty.

As part of Lockheed, it will now be able to diversify. ♦♦



**Boeing's Solar Concentrator**

PROTOTYPE DISH-SHAPED mirror may provide key to efficient electric power source for long-term spaceflight. Reflecting surface is composed of vacuum-deposited layer of silicon monoxide and aluminum. Boeing-developed prototype weighs 16½ lbs.

**GENERAL ELECTRIC CORP.** established a new Business Development Planning Organization.

The group will prepare and issue company business plans for future undersea warfare, missile defense and aerospace defensive systems, as well as radar, underwater acoustic, signal processing and display and specialized communications equipment.

The organization's three main functions will be;

—Technological Applications and Analysis

—Market Research and Planning

—Advance Business Planning.

**GULTON INDUSTRIES, INC.** acquired the Mervyn Sound and Vision Co., Ltd. a British scientific research and manufacturing company. Gulton president Dr. Leslie Gulton said the transaction was completed for a sum in excess of \$500,000.

**AIR PRODUCTS, INC.**, Allentown, Pa., has changed its name to Air Products and Chemicals, Inc.

The company has also acquired the business and assets of Delta Oxygen Co., Inc., Memphis, Tenn.

**SPACE EQUIPMENT CORP.**, Torrance, Calif., is constructing a new headquarters. The first unit, scheduled for completion Oct. 1, will house the company's offices, engineering department and research labs.

**WYLE LABORATORIES** acquired the stock of Ransom Research Inc. and Ransom Systems through an exchange of stock.

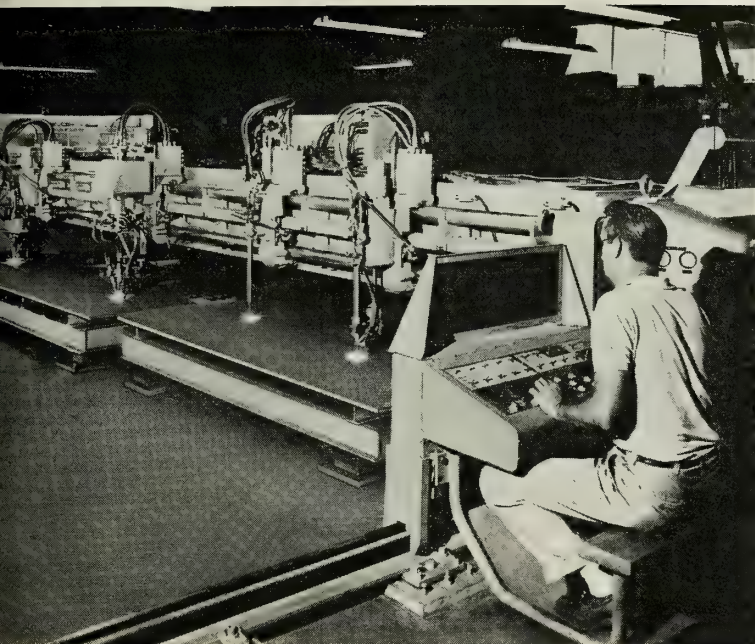
The Ransom companies specialized in design and manufacture of solid-state digital systems and components for aerospace GSE and for industrial applications. Most recent system installation provides complete data reduction facilities at CalTech's JPL for use in the NASA *Ranger* program.

**CHRYSLER CORP'S** Missile Div. has acquired new facilities in Melbourne, Fla., in a move to expand its engineering, manufacturing and range support operations in the Cape Canaveral area.

**COLLINS RADIO CO.** consolidated its two electronic component operations into a single division, the Communications Accessories Co.

Affected are the mechanical and crystal filter facility, Santa Ana, Calif., and Communications Accessories Co., Lee's Summit, Mo.

Combined product lines of the new divisions include toroidal coils and transformers, laminated transformers, magnetic amps, ferrite products and LC, mechanical and crystal filters.



## Tape-Controlled Flame-Cutter

The first numerical-control tape flame-cutting machine, developed by Air Reduction Sales Co. in cooperation with General Electric Co., is an automatic rectilinear bridge type unit capable of cutting straight lines and contours in plate of any length, 22 ft. wide and up to 6 in. thick. The machine eliminates the need for templates and template tables, and for an operator to

control the flame-cutting process. The cutting system consists of two main components—the director—a General Electric Mark Century Numerical Contour Control System, and the cutting machine proper. The unit provides fully automatic control of flame-cutting operations by means of predetermined, numerically coded instruction.

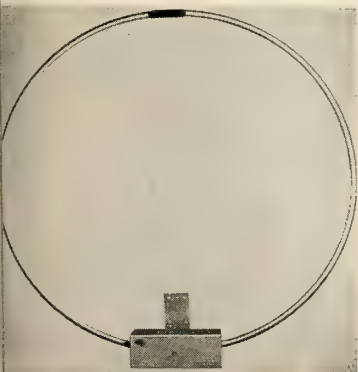
Circle No. 225 on Subscriber Service Card

## Shielded Loop Antenna

Aerospace Research, Inc. has developed a balanced, self-supporting, electrostatically shielded loop antenna ruggedly designed for outdoor installation in any environment. The L-I Loop Antenna has been specifically developed for use at low and very low frequencies

where electrostatic shielding is usually necessary for proper reception. The loop can be used for calibrated measurement as well as for normal reception. The antenna has a diameter of one meter and is provided with a universal mounting bracket.

Circle No. 226 on Subscriber Service Card



## Solid Tantalum Capacitors

Texas Instruments Inc. has announced the expansion of its line of tan-TI-cap solid tantalum capacitors. Twenty-eight new low-capacitance ratings, 0.0047  $\mu$ f through 0.82  $\mu$ f, bring the number of standard capacitance-voltage-tolerance ratings of TI's electrolytic capacitors to over 250. Packaged in the small-type SCM "F" case, these miniature capacitors are available in 20 v or 35 v d-c voltage ratings. They are offered in  $\pm 10\%$  and  $\pm 20\%$  tolerances and 10% decade ratings; other tolerances available on special order.

Circle No. 227 on Subscriber Service Card

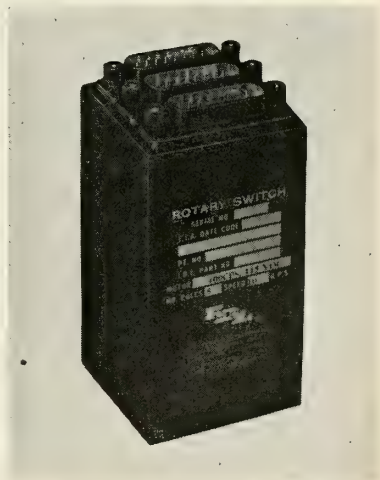
## No-Lube Sleeve Bearings

Self-lubricating sleeve bearings, which will be marketed under the trade name of Neverlube, are available from Carter Manufacturing Co. The design is a machined-steel outer sleeve or cartridge in which an oil reservoir, in the form of internal grooves, has been provided. The oil reservoir is filled with a special oil during assembly of a sintered bronze bushing. Capillary action of the oil in the reservoir through the sintered bushings provides a continuous oil film between the assembled bearing bore and shaft for a substantial period of operation.

Circle No. 228 on Subscriber Service Card

## Miniaturized Switches

Miniaturized telemetering commutators, averaging 60% smaller and 50% lighter than previous IDL standard models, have been put on the market by Instrument Development Laboratories, Inc. These miniaturized commutating switches have been operated under environmental conditions without drop-out, noise, bounce or signal contamination. One model equipped with the new IDL clamped speed regulator weighs 17 oz., has a power consumption



of 150 ma at 27 vdc, and is reported to provide frame rate stability of better than  $\pm 3\%$ .

Circle No. 229 on Subscriber Service Card

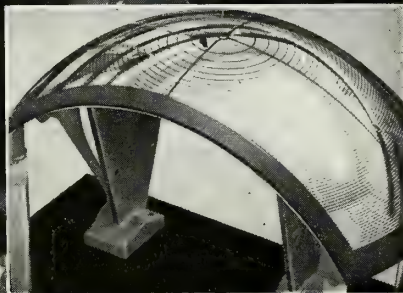
## Chevron Baffle-Cold Trap

NRC Equipment Corp. has introduced a complete line of optical baffle-cold traps for vacuum pumping systems. The traps feature a circular chev-



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ron design with the coolant reservoir centrally located in the assembly. The baffle-cold traps are optically opaque, which means that gas or pumping vapor molecules, which travel in straight lines at high vacuums, cannot pass through the assembly without striking a baffle surface.

Circle No. 230 on Subscriber Service Card

## Automatic Testing System

A system which digitally measures the elapse time between any two points on a high-speed waveform is available from Dymec, a division of Hewlett-Packard Co. The DY-5844 automatic waveform-measuring system will measure time intervals between any two points chosen from the 0-100% level of either stimulus or response pulse. Accuracy is better than  $\pm 4\%$  of full scale,  $\pm 0.4$  nanoseconds. In addition to measuring transistor, delay, rise, storage, and fall time, the DY-5844 will make similar measurements on diodes, magnetic cores, and high-speed components and circuits.

Circle No. 231 on Subscriber Service Card

## Correction

*M/R, Sept. 4, printed this photo of Avco's new plasma gun sans story (below).*



A compact, lightweight plasma gun designed for industrial use is in production at Avco Corp.'s Research and Advanced Development Division. Only 5 in. long and weighing  $3\frac{1}{2}$  lbs., the entire gun assemblies with only four bolts securing precision-machined, self-aligning, piloted parts. Its makers say it will spray coating—including refractories—with a controlled thickness, density, and bond strength that could never be obtained before. It reportedly deposits a coating at twice the rate of comparable competitive models, and at savings up to 30% over existing coating processes such as oxyacetylene flame-spraying.

Circle No. 232 on Subscriber Service Card

missiles and rockets, September 11, 1961



## STANCE: Litton Systems Advance the Defense Posture of the Free World

The need is urgent. It will be met. By free men acting with renewed faith. Armed by advanced in-being systems such as those to be displayed at the Litton Systems booth at the Air Force Association show this month. You are invited to see them. To study the Litton record of system management and technical creativity for USAF and other defense forces of the free world. To evaluate the meaning of that record in relation to our present and future defense posture.



**LITTON SYSTEMS, INC.**  
BEVERLY HILLS, CALIFORNIA  
A DIVISION OF LITTON INDUSTRIES

Guidance & Control Systems • Computer Systems • Command and Control Systems • Space Science  
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CHARITY,  
GEORGE!"**

*"Contributions to the United Fund are really investments! Sure, charity takes the edge off hunger and misery. And that's necessary. But the agencies of the United Fund go way beyond that. They give the help that gets people back on their feet, makes them productive members of the community again. So it makes good sense to give the United Way—as an investment in a stronger, more prosperous community. Besides, that's the American way: to take care of our own, right at home. Our company makes a contribution, urges its employees to join in and makes it convenient through payroll payments. This once-a-year appeal cuts down the confusion of separate drives, too. It's more than a charity, George. It's an investment—and a duty—for your business and mine!"* **GIVE THE UNITED WAY**

(Continued from page 21)

updating of target position and velocity data. While this version of the system is capable of coordinating and directing many fire units, the GSG-6, routing externally-generated data and/or locally-generated pointing data, can only manage the activities of a limited number of units.

The electronic, semiautomatic air defense coordination system consists of the air defense radar, communication and data transmission links, visual display consoles on which the area aircraft situation is displayed, computers and fire unit integration facilities and primary and secondary power supplies. The entire system is housed in standard Army shelters, 18 ft. long, 8 ft. wide and 7½ ft. high, and is transportable by air, rail or road.

One of the prime factors in the reduction in size for the BIRDIE system is the use of approximately 3000 transistorized printed-circuit cards which make up the heart of the digital data processing system. By careful planning, the more than 12,000 digital circuits have been arranged so that they can be produced almost on a mass-production basis—at 1/15th the cost of producing these cards in the past.

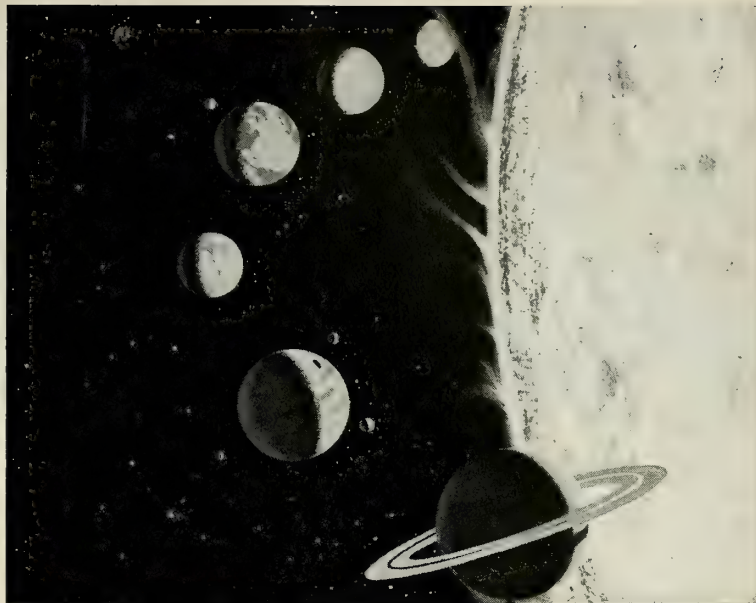
• **Highly flexible**—To illustrate the flexibility of the system, engagement evaluation, aircraft identification and target assignment can be made by either the higher headquarters or the BIRDIE coordination center.

Using automatic digital data communications, the system receives from higher headquarters the track position, velocity and auxiliary data, and transmits the battery track position and auxiliary data in addition to battery repeat-back data, target reference and target designation data. In the continental U.S. these data links are Bell A-1 data service with higher commands and AN/TSQ-8 type service with the fire units.

The primary power for the system is furnished from commercial or standard military generators producing 120/208 volt, three-phase, four-wire, 60-cycle power. The load requirement for each of the three shelters is: 8 kw. for the equipment shelter; 9 for the one-console and equipment shelter; and 3 for the two-console shelter.

Operating in an environment from -40°F to +125°F, the system requires no site preparation prior to installation. All inputs and outputs are terminated at a demarcation panel for maximum flexibility. ■

missiles and rockets, September 11, 1961



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Continued expansion of our aerospace systems programs has created additional openings for highly qualified engineers and scientists to participate in company studies on many advanced projects. Challenging positions now exist in the following areas of specialization:

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**AERODYNAMICS ENGINEERS** To perform aerodynamic analyses on advanced configurations for lift, drag, stability, control, loads, and heat transfer. Familiarity with subsonic and supersonic aerodynamic theory required. Familiarity with wind tunnel testing desirable. Openings exist at all levels, but major requirement is for senior men capable of assuming complete responsibility for a major program and/or supplying expert consultation to advanced design studies.

**AIRBREATHING PROPULSION SPECIALISTS** To conduct long range analytical and experimental programs in development of air induction and exhaust systems for airbreathing propulsion systems. Emphasis will be on pushing the range of applicability to highest possible Mach number. Advanced degree or applicable experience required.

For additional information, please address a resume or letter of inquiry to:  
**Mr. B. J. Cunningham, Manager, Employment Services,**  
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All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

**SPACE & INFORMATION SYSTEMS DIVISION**  
NORTH AMERICAN AVIATION





## NASA

- \$348,643—**S&Q Construction Co.**, San Francisco, for test-section components and auxiliary piping systems for the mass transfer cooling and aerodynamic facility, Ames Research Center, Moffett Field, Calif.
- \$310,000—**The Martin Co.**, Baltimore, for production of heat exchanger units for *Saturn C-1* boosters.
- \$183,875—**Electronic Associates, Inc.**, Long Branch, N.J., for computer system for Lewis Research Center, Cleveland.
- \$49,000—**Fluidyne Engineering Corp.**, Minneapolis, for designing aerodynamic components for an arc-driven hypersonic wind tunnel, Research Center, Langley, Va.

## MISCELLANEOUS

- \$750,000—**The Bendix Corp.'s Industrial Controls** section, Detroit, from Douglas Aircraft, for transistorized tape-controlled contouring systems for machine tools.
- \$370,000—**Vehicle Research Corp.**, Pasadena, Calif., from Maritime Administration, for design of a "surface effect ship" which would travel above the water on a cushion of air at speeds of 100 mph or more. **Douglas Aircraft Co.** will be the major subcontractor and presumably the builder of the ship.
- \$146,500—**Fluidyne Engineering Corp.**, Minneapolis, for design, fabrication and erection of a rocket test facility; \$50,000 for research for flow studies of rocket motor exhaust gases, both from **Hercules Powder Co.**
- \$32,000—**Fluidyne Engineering Corp.**, Minneapolis, from North American Aviation,

for fabrication of hypersonic wind tunnel nozzles.

## NAVY

- \$2,500,000—**Gould-National Batteries, Inc.**, St. Paul, for production of submarine batteries.
- \$1,650,000—**Stanford University**, Palo Alto, Calif. from ONR, for continuation of a Navy-Air Force program supporting basic studies of the nuclear structure and properties of the elementary particles of nature.
- \$1,033,000—**Reaction Motors Div., Thiokol Chemical Corp.**, Bristol, Pa., for production of Model LR 62 RM-2 packaged liquid rocket engines for the *Bullpup B* air-to-surface missile.
- \$850,000—**Packard Bell Electronics Corp.**, Los Angeles, for airborne recorders used in antisubmarine warfare and for an automatic checkout system for a French ballistic missile.
- \$270,000—**Electro Steel Structures, Inc.**, and **Western Erectors, Inc.**, Rialto, Calif., for construction of a *Scout* launch complex at Naval Missile Facility, Point Arguello, Calif.
- \$155,242—**General Electric Co.**, LMED, Ithaca, N.Y., for design, development and fabrication of an airborne infrared vidicon system suitable for radiometric and spectrometric measurements of target characteristics from an airborne platform.
- \$120,000—**Douglas Aircraft Co.**, El Segundo, Calif., from BuWeps, for an 18-month study of thermoelectric power system using waste heat from jet or rocket engines for both electrical power and cooling.

**Westinghouse Electric Corp.**, Lester & E. Pittsburgh, Pa., for development and production of a 400-cycle turbine-generator and related switchgear to provide power for the *Typhon* weapon system. No amount disclosed.

## ARMY

- \$21,000,000—**The Martin Co.**, Orlando, for continued work on the *Pershing* missile system.
- \$6,433,884—**Hercules Powder Co.**, Radford, Va., from Ordnance Ammunition Command, Joliet, Ill., for work in propellants and explosives.
- \$1,728,891—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts and modification kits for the *Hawk* missile system. 2 contracts.
- \$1,250,000—**Continental-Emsco Co.**, Dallas, a division of **The Youngstown Sheet and Tube Co.**, for delivery of 57 sets of wheel truck assemblies for all *Titan II* ICBM sites.
- \$475,000—**Adler Electronics, Inc.**, for production of three transportable AN/TSC-20 communications centrals.
- \$191,291—**Western Electric Co.**, New York City, for procurement of *Nike* replenishment spare parts and repair parts. 2 contracts.
- \$56,500—**Armour Research Foundation**, Illinois Institute of Technology, Chicago, from Signal Corps, for development of a new high-temperature solar cell.

## AIR FORCE

- \$10,935,000—**Allison Div.**, General Motors, Indianapolis, from **Thiokol Chemical Corp.**, for production of first-stage rocket engine cases for the *Minuteman* ICBM.
- \$3,140,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for installation and on-site verification testing of AN/FPS-35 radar set.
- \$1,090,614—**Hughes Aircraft Co.**, Culver City, Calif., for partial production of infrared sight systems.
- \$1,500,000—**Sylvania Electric Products, Inc.**, New York City, for production of miniature and subminiature electron tubes.
- \$600,000—**Motorola, Inc.**, Chicago, for QRC-170 transportable jammer.
- \$449,999—**Bendix Corp.'s Support Equipment Div.**, Teterboro, N.J., for product improvement for the AN/GJQ-9 sequency programming sets.
- \$442,950—**North American Aviation, Inc.**, **Rocketdyne Div.**, Canoga Park, Calif., for administrative documentation and other support under WDT Exhibit 57-2 for provisioning of initial spare parts for the WS107A-1 propulsion system and related AGE.
- \$378,000—**The Boeing Co.**, Seattle, from AFSC, Edwards AFB, for applied research and testing on problem areas which will be encountered in the development of 1- to 9-million-lb.-thrust booster propulsion subsystems and to initiate selected programs toward the solution of critical problems.
- \$188,907—**Airborne Instruments Lab.**, Long Island, N.Y., for AN/GPX-27 interference blanker group.
- \$132,971—**J&H Smith Mfg. Co.**, Newburgh, N.Y., for airborne training rocket launcher, Type MA2A.
- \$94,728—**Electro-Optical Systems, Inc.**, Pasadena, Calif., from Rome ADC, for development of advanced laser components for use in optical surveillance systems.
- \$31,000—**McCormick Selph Associates**, Hollister, Calif., from Lockheed Missiles and Space Co., for design of dual-carriage explosive bolt for *Discoverer* program.



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Square and rectangular shaped wires are frequently used in modern "wrapped" terminal and pin or plug type connectors. For this application the edges must be finished quite sharp (usually .003 radius corners or less) but without a burr or flashing. Also required are closely controlled dimensional tolerances and smooth finish. Uniformity of temper is essential. Therefore close control of all facets of wire manufacturing is of paramount importance.

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SEPTEMBER

**Fall Instrument-Automation Conference and Exhibit and 16th Annual Meeting, Instrument Society of America, Biltmore Hotel, Los Angeles, Sept. 11-15.**  
**Fall Conference, Electronic Industries Association, Biltmore Hotel, New York City, Sept. 12-14.**  
**International Operations and Maintenance Symposium, Airwork Corp., Millville, N.J., Sept. 13-14.**  
**Technical-Scientific Communications Conference, IRE, Bellevue-Stratford Hotel, Philadelphia, Sept. 13-15.**  
**16th Annual Meeting of Armed Forces Chemical Association, Statler-Hilton Hotel, Washington, D.C., Sept. 13-15.**  
**Symposium on Materials in the Space Age, Aeronautical Systems Division of the AFSC (invitation only), Phoenix, Ariz., Sept. 13-15.**  
**9th Annual Joint Societies Engineering-Management Conference, IRE, Hotel Roosevelt, New York City, Sept. 14-15.**  
**Conference on Technical-Scientific Communications, IRE, Bellevue-Stratford Hotel, Philadelphia, Sept. 14-15.**  
**16th Detroit Quality Control Forum, cosponsored by Greater Detroit Section of American Society for Quality Control and University of Michigan, Angell Hall, University of Michigan, Ann Arbor, Sept. 16.**

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Anti-Gravity Devices

(Continued from page 31)

In the electromagnetic case, the current  $I$  through the wire causes a magnetic field  $B$  in the torus. If the current is constantly increasing, the magnetic field also increases with time. This time-varying magnetic field then creates a dipole electric field  $E$  (see Fig. 1a).

In the gravitational analog the mass flow  $T$  through a pipe wound around a torus, causes a field  $P$  in the torus. If the flowing mass is accelerated, then the  $P$ -field increases with time. This time-varying  $P$ -field then creates a dipole gravitation field  $G$  (see Fig. 1b).

Unfortunately, since the "gravitational permeability of space" has the very small value of  $\eta_g = 3.73 \times 10^{-26}$  meters per kilogram, it would require very large systems to obtain even a measurable amount of gravitational acceleration, much less anti-gravity.

For example, if it were somehow possible to create and contain matter with the density of a dwarf star, and if we could somehow accelerate it through pipes wide as a football field wound around a torus with kilometer dimensions, then we would create a gravitation field at the center of the torus of about  $G = 10^{-10}a$ , where  $a$  is the amount of acceleration we can give the dwarf star material.

If it were then somehow possible to generate enough force to accelerate all this mass at  $10^{11}$  meters per sec<sup>2</sup>, then we could counteract the earth's gravitation field for a few milliseconds. The reason for this time limitation is that at an acceleration of  $10^{11}$  m/sec<sup>2</sup>, it takes only a few milliseconds to reach the speed of light.

• **Future lines of attack** — It is obvious that the minimum material and force requirements for this particular model are so far from present capabilities, that unless a major breakthrough is made practical anti-gravity will be technologically impossible for centuries.

Since the strength of all the gravitational effect depends directly or indirectly on the density of the material, the best area for future research in gravity is in super-dense materials. We know the materials exist since a large percentage of the stars in the sky are dwarf stars. These dwarf stars have the same mass as the sun, but their volume is comparable to the earth. The densities have been estimated to be around  $10^8$  to  $10^{12}$  gm/cc.

Whether such "collapsed matter" can be made, and whether it can be kept stable once made, are difficult questions that cannot be answered without much more research. #

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## The Death of a Citizen

**W** E ADMIRE and respected him always. His quiet strength and his vision were an asset not only to the company he guided but to the entire nation.

The passing of Robert E. Gross leaves us all poorer.

Our first connection with the Lockheed board chairman was a remote but intensely personal one. We flew one of his P-38's. It was a fine airplane. The test pilots he sent out to work with the squadrons were fine men.

The personal contact of later years did nothing to change the respect arising out of our wartime experiences. The informative, almost scholarly discussions with the man in the Lockheed front office always left a deep impression. Mr. Gross was a gentleman in the truest sense of the word. He also was a gentleman who knew what was happening in his company and where it should be going. Lockheed's transition into the missile/space industry was under the leadership of a man who looked to the future and drew thoughtful conclusions from what he saw there.

"You look ahead, not back," he once said. "You look ahead where the horizons are absolutely unlimited."

That philosophy carried the company to its prominent position in the new field of missiles and space. The *Polaris* missile and the *Agena* space vehicle are but two manifestations in hardware of that wisdom.

When Mr. Gross and a group of associates purchased the assets of Lockheed in June, 1932, the bankrupt company then had less than 60,000 square feet of rented factory space. Today, it is America's 28th largest industrial firm, a 16-million-square-foot industrial giant with 66,500 employees, net assets of \$548 million, and yearly sales of better than \$1 billion.

It is a leader in missiles, space and related fields, respected throughout the world for its accomplishments.

But it was not only for his part in that amazing growth that Robert Gross was known. He was not only a business man; he was, in the most unobtrusive way, a citizen.

University of California President Clark Kerr called him a "civic leader with a deep sense of human values."

To know something of the kind of man he was, it is necessary only to look at his achievements outside the company. He was a trustee of The Boys Club of Southern California, a member of the board

of the Arthritis and Rheumatism Foundation, chairman of the United States Savings Bond Campaign in 1957, vice chairman of the United Community Campaigns of America, a member of the boards of The Good Samaritan Hospital in Los Angeles and The Children's Hospital in Boston, a member of the Art Council of the University of California at Los Angeles, and an overseer of his own alma mater, Harvard.

He was named California Industrialist of the Year in 1959. He was president of the Institute of Aeronautical Sciences in 1955. In June of this year, he was cited by the National Conference of Christians and Jews for his personal service in the cause of good brotherhood.

The Lockheed plan to broaden opportunities throughout the company for employment and advancement of minority groups was called by President Kennedy "a milestone in the history of civil rights."

Lockheed is a leader in employment of handicapped workers, in funding scholarships for worthy students, in sponsoring medical research.

At the same time, it is known as a hard fighter for contracts. Ask anyone who tangled with the company when it was selling the F-104 to Europe. Several British and U.S. firms still are rubbing their bruises.

**A** LL OF THIS is a tribute to the quiet man who was chief executive officer and board chairman. And now he is gone.

We last saw Robert Gross some weeks ago here in Washington. During our brief chat in a hotel lobby, his handshake was firm and his eyes were clear.

The closing of those eyes has cut off a vision that will be sorely missed by his company, his industry and his country.

Perhaps the finest obituary for Robert Gross may be found in a speech he himself made in San Francisco last February.

"We have soared above into the clear colorless regions of space where the 'white radiance of eternity' is unstained and where truth may be found pure and undistorted. It is my hope that our penetration of space will bring this white radiance into the lives of all of us and that our expanding knowledge of the universe will be matched by an increasing knowledge of how to live with each other."

Hail and farewell.

William J. Coughlin

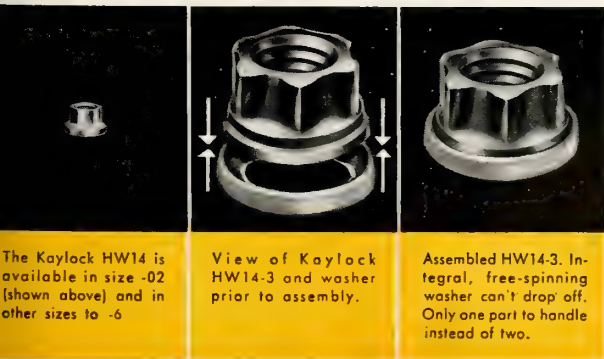


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On America's drawing boards and in the laboratories are two, three and five-man spacecraft, space platforms and manned lunar craft. The goal is interplanetary flight. Eventually, lifetimes may be devoted to a single space adventure.

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schoolroom for future astronautics students making their first leaps into space.

Months of ground training will be necessary for coming space explorers. Then will come trajectory flights to experience weightlessness and spacecraft control. Earth-orbital flights will acquaint the future astronauts with spacecraft control, celestial and ground observation, re-entry techniques, artificial atmosphere and other environment concepts.

Only after he has mastered the "one-room schoolhouse of the space age" will the astronaut be ready to man a deep space vehicle.

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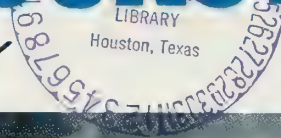
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SEPTEMBER 18, 1961

# missiles and rockets

THE MISSILE SPACE WEEKLY



Fourth Annual GSE Special Issue

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## *...roll on through pathless realms of space...Gilbert*

The Range Planning Department of Pan Am's Guided Missiles Range Division is increasing its technical staff to meet the demands of the accelerated space progress, as a part of a well-organized systematic expansion program.

GMRD's Range Planning engineers plan the instrumentation, facilities and logistics necessary to support tests of the nation's most advanced aerospace systems on the Atlantic Missile Range. Plans are developed for specific programs such as DYNASOAR and CENTAUR, as well as for general expansion and improvement of the range. Major planning areas are in logistics, data acquisition systems, data support and facilities.

The Range Planning Department offers men with creative ability and initiative the opportunity to proceed from

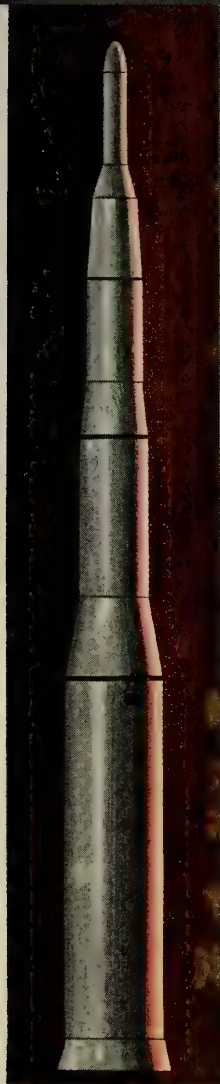
concept to hardware. The programs are important . . . the funds are available . . . the tools are at hand. The need is for technically respected people with leadership ability to carry out these programs.

New career positions are also available in engineering and operations. Physicists, engineers and mathematicians with B.S., M.S. and Ph.D. degrees are invited to submit resumes in confidence. Address Professional Employment Manager, Guided Missiles Range Division, PAN AMERICAN WORLD AIRWAYS, INC., Dept. V-42, P. O. Box 4336, MU 113, Patrick Air Force Base, Florida. Inquiries will receive prompt replies and all qualified applicants will be considered for employment without regard to race, creed, color or national origin.



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ease of layup, and increase flexibility and resilience of final laminate.

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# missiles and rockets

Volume 9, Number 12

September 18, 1961



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## THE COVER

Takeoff of a lunar probe vehicle in this con-  
ception by Martin Electronics Division gives  
indication of massive GSE needed for com-  
ing space launchings. See p. 18.

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## letters

### SLAM's Future

To the Editor:

CONGRATULATIONS ON THE VERY FINE SEPT. 4 EDITORIAL ("SLAM: TIME TO FISH OR CUT BAIT"). YOUR APPRAISAL OF THE SLAM PROGRAM IS BOTH ACCURATE AND TIMELY.

W. J. Hesse  
Chance Vought Corp.  
Dallas

### Ski-launch Reopened

To the Editor:

I have been following your Letters section expecting to see an answer to the question raised in the letter from Mr. Lucien Greif (M/R, Aug. 21, p. 7), namely, would not a missile launched by the rumored Russian ski-launch system (Letters, M/R, July 31, p. 6) lose all of the kinetic energy in going up hill that it had gained in going downhill?

It would, of course, if allowed to go up as far as it originally came down, and nothing would be gained in such a launch if the rocket motor were not fired until it came to a stop. The object, however, would be to fire the rocket motor at its point of greatest speed, because the efficiency of such a motor would then be maximum. In fact, the efficiency of a rocket motor is zero at the time of launch (if the missile is not moving) and reaches 100% when the missile's velocity just equals the exhaust velocity of the gases. That is one reason why the second stage of a missile, carrying far less propellant than its first-stage booster, can gain more in velocity than that imparted to it by the first stage.

David Fulton, President  
Hydro-Space Technology, Inc.  
West Caldwell, N.J.

### Hypervelocity Tunnels

To the Editor:

Mr. Reed Bundy's article on R&D in the Princeton area ("Princeton Climate Spurs Research," M/R, Aug. 21, p. 32), including the very important contributions on missile/space research by Princeton University's Gas Dynamics Laboratory, was well written and comprehensive.

However, I'm sure Prof. Bogdonoff and his associates at the Laboratory will not object to one correction in the article.

Specifically, the statement "It (the laboratory) has also supplied invaluable knowledge of gas dynamics—including the only available performance data on speeds from Mach 15 to Mach 20."

As a spokesman for the Arnold Center I concur completely that the Princeton group has provided a great fund of invaluable data, but I question the latter part of the statement. For the past three or four years we at the Arnold Engineering Development Center have had in operation two arc-driven wind tunnels providing information in the Mach 16 to 21

area. These have 16- and 50-inch-diameter test sections, respectively; and a third with a 100-inch test section is beginning shake-down operations. . . . These are part of the Center's von Karman Gas Dynamics Facility and were developed by the Center's Operating Contractor, ARO, Inc.

By the way, your article "Arnold Center Tests All Big Systems" (M/R, Aug. 14, p. 31) was greatly appreciated. Mr. James Trainor did a commendable job in describing the Mach 15-20 (16-21) Tunnels on p. 34.

Leon S. Jablecki, Colonel, USAF  
DCS/Operations  
Arnold Engineering Development  
Center, Tenn.

M/R erred in saying "only available performance data" on Mach 15-20 speeds, the mistake was the writer's not the university's. However, it should be noted that Princeton's helium tunnel can be run for as long as 10 minutes, whereas the "hot shot" nitrogen tunnels at Arnold have a 100-millisecond limit.—Ed.

### Spaceware & Earthenware?

To the Editor:

Ref COUNTDOWN item, M/R, Aug. 28, p. 9, titled "New Products Names Dept." (reporting that the Air Force is distinguishing between equipment and incorporeal products by applying the name "hardware" and "software"): And I suppose the Navy is working on "Surface ware" and "Underware"—This could go on and on!

W. A. Koch  
Aberdeen Proving Ground, Md.

### Concerning STL

In our story "Will Congress Regulate 'Non-profits'?" (M/R, Aug. 28, p. 12), Space Technology Laboratories, Inc., was listed, with "non-profit" organizations, in a box showing firms under contract to the Air Force for research and development.

Some readers inferred from this that we were indicating STL as a "non-profit" corporation. This, of course, is not true. STL, a subsidiary of Thompson Ramo Wooldridge Inc., is a private enterprise corporation. It is financed wholly by private investors and operates under the same conditions as any other competitive industrial company.

It was, in fact, congressional criticism of possible "conflict of interest" in the relationship between STL, TRW and the Air Force that led to establishment of the "non-profit" Aerospace Corp.

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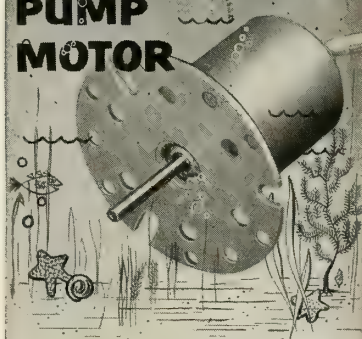
### SEPTEMBER

- 10th Annual Industrial Electronics Symposium, IRE, Bradford Hotel, Boston, Sept. 20-21.
- AEC Welding Forum, Annual Meeting (classified), Southwest Research Institute, Granada Hotel, San Antonio, Tex., Sept. 20-22.
- Air Force Association's 1961 Convention and Aerospace Panorama, Convention Hall, Philadelphia, Sept. 21-24.
- Industrial Building Exposition and Congress, New York Coliseum, New York City, Sept. 25-28.
- National Fall Meeting, American Welding Society, Hotel Adolphus, Dallas, Tex., Sept. 25-28.
- European Congress on Aviation Medicine, Paris, Sept. 26-30.
- Manufacturing Chemists' Association, General Safety Committee Workshop, Niagara Falls, Canada, Sept. 27.
- 3rd Annual Missile Symposium, The Hyatt House, Seattle, Sept. 27-29.

### OCTOBER

- 7th National Communications Symposium, IRE Professional Group on Communications Systems, Utica, N.Y., Oct. 2-4.
- IRE Canadian Electronics Conference, Automotive Bldg., Exhibition Park, Toronto, Oct. 2-4.
- XII International Astronautical Congress, hosted by American Rocket Society, Washington, D.C., Oct. 2-7.
- 8th Annual Science & Engineering Symposium, AFSC and Aerospace Research, Sheraton-Palace Hotel, San Francisco, Oct. 3-4.
- 9th Annual Human Engineering Institute, Stamford, Conn., Oct. 3-6.
- American Society of Photogrammetry Semi-annual Convention, Biltmore Hotel, New York City, Oct. 4-6.
- 17th National Electronics Conference and Exhibition, International Amphitheatre, Chicago, Oct. 9-11.
- National Aeronautic and Space Engineering and Manufacturing Meeting, sponsored by Society of Automotive Engineers, Hotel Ambassador, Los Angeles, Oct. 9-13.
- Space Flight Report to the Nation, American Rocket Society, New York Coliseum, New York City, Oct. 9-15.
- Symposium on Shock, Vibration and Associated Environments, sponsored by DOD, Office of Director of R&E, Detroit, Oct. 10-12.
- Optical Society of America Meeting, Somerset Hotel, Boston, Oct. 12-14.
- 17th Annual ISA Instrument-Automation Conference and Exhibit, New York Coliseum, New York City, Oct. 15-19.
- Second International Congress, International Organization for Vacuum Science and Technology, Eighth Annual Symposium of the American Vacuum Society, Washington, D.C., Oct. 16-19.

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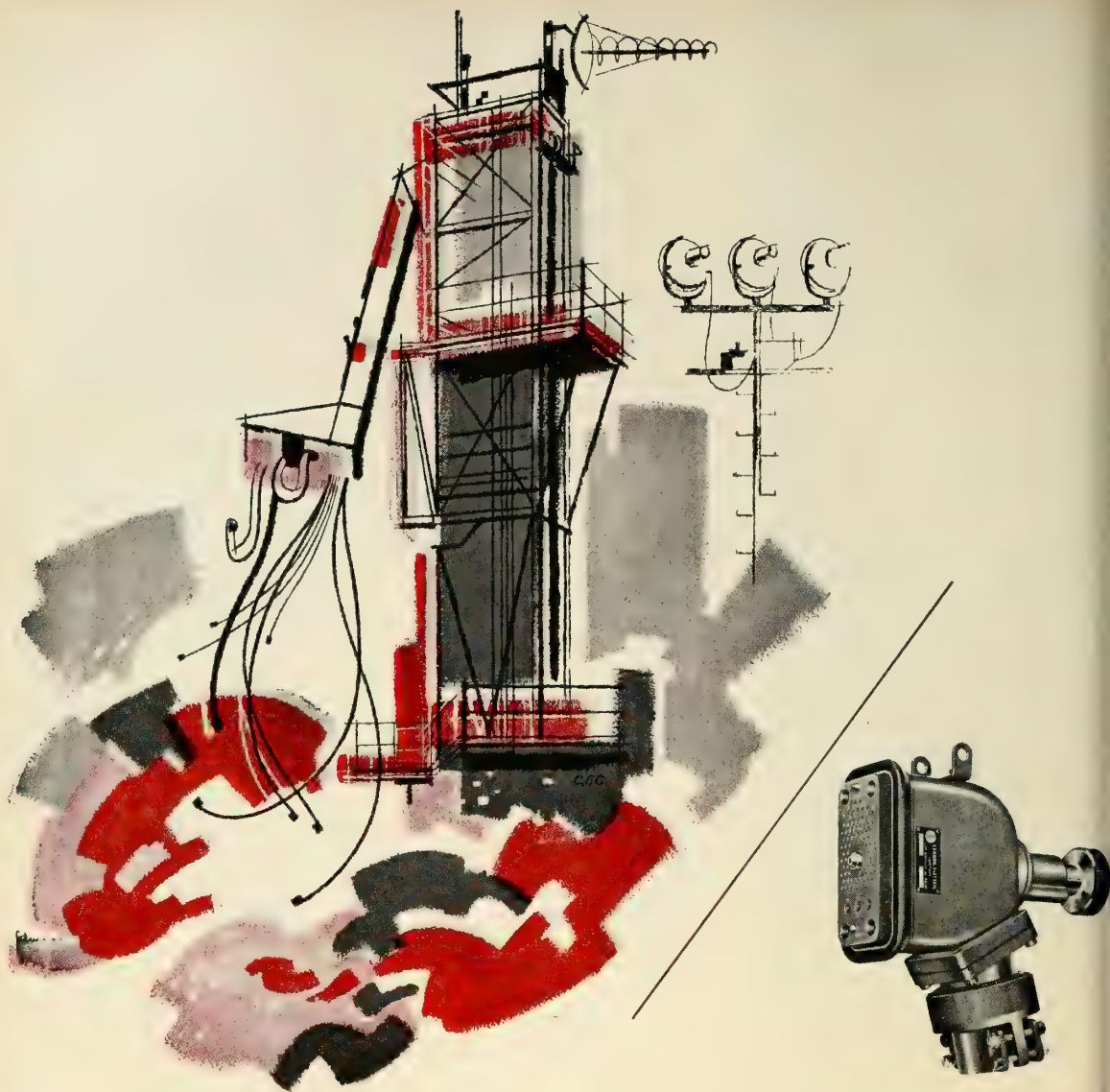
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# The Countdown

## WASHINGTON

### Re-evaluating Minuteman

Soviet plans to develop a 100-megaton nuclear warhead are forcing some agonizing reappraisals of the strategic program packages submitted to the Defense Department for budget review. Among the key questions: Should hardening of fixed *Minuteman* sites be greatly increased (M/R, Sept. 11)? Have the mobile *Minuteman* and the mobile *Polaris* become more attractive than a large expansion of the planned number of fixed *Minuteman* squadrons?

### Boosters on Capitol Hill

The Senate Space Committee's forthcoming hearings this month are aimed at shedding some light on NASA-DOD plans in the national space booster program. The committee wants to pinpoint where the plans for development of superboosters are heading—and how much they are going to cost.

### Zeus at Pt. Mugu: No. 2

A second launching of *Nike-Zeus* from Pt. Mugu down the Pacific Missile Range is expected within about one month. The first flight on Sept. 9 was only partially successful, but it is not expected to cause any slippage in the test program. First tests from Kwajalein are expected early next year. Some observers are now betting on nuclear-warhead tests with *Zeus* before 1962 is out.

### No Pad Slip for Samos

Damage to the *Atlas-Agena* launching pad at Pt. Arguello caused by the explosion in the Sept. 9 *Samos* launching attempt is not as extensive as first believed. Moreover, a second pad is available and others are under construction. Therefore, no slippage because of a pad shortage is expected.

## INDUSTRY

### R&D Intelligence

COUNTDOWN hears Martin's *Pershing* has not met Army specs for low-temperature operation; a development program is under way to cure this problem. . . . Sylvania Electric expects to complete ground installations for the Army's *Advent* satellite next month at Fort Dix, N.J., and Camp Roberts, Calif. . . . At the Eglin Gulf Test Range, the Air Force is preparing to launch *Nike-Cajuns* to take IR measurements at 70 miles. . . . Marquardt has run a 25-lb.-thrust, radiation-cooled bipropellant (hydrazine and nitrogen tetroxide) pulse rocket continuously for 46 minutes.

### Apollo's Management (Cont.)

NASA officials are letting it be known that they expect to have 300 persons on the *Apollo* management team in their Washington headquarters. Incidentally, this may come as a surprise, but NASA Administrator Webb says he has told President Kennedy that many people feel the *Apollo* program has been moving too fast.

## Boosting Bomarc

With completion of the *Bomarc B* flight test program (35 shots), Boeing Co. is understood to be pushing a campaign to extend the *Bomarc* program—including a mobile model. Russia's unveiling of new jet bombers is salting the sales talk to NORAD.

## Trend in Navy Drones?

Drone manufacturers are taking special note of a Navy decision to develop a Mach 2 tow target for use with the GE/Philco *Sidewinder* and Raytheon *Sparrow III*. The tows could be used with the McDonnell F4H and various Air Force Mach 2 interceptors.

## The Price of SINS

The cost of Autonetics' SINS—ships inertial navigation systems—for *Polaris* nuclear-powered submarines is running at about \$600,000 per ship. This figure includes stock components and shore systems. Each *Polaris* sub carries three SINS.

## PERT, PERT, and More PERT

The Air Force is moving toward ever-greater use of the PERT system for keeping track of R&D programs and avoiding slippages. The Air Force Systems Command is understood to be looking for a number of new areas for using PERT in its many programs. At the same time, NASA also is embracing the Navy-developed management tool.

## INTERNATIONAL

### Still Sought: AA Missiles for Israel

The Israelis are continuing to press for permission from one NATO government or another to buy air defense missiles. The Israelis want to ring their principal cities with air defense missiles to defend themselves against a possible Arab surprise attack.

### Germany to Top Blue Streak

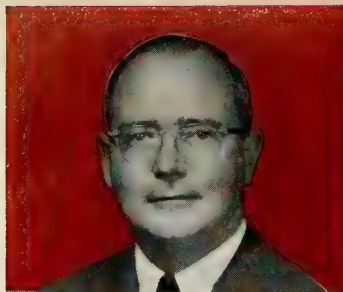
The West Germans definitely will develop a third stage for the *Blue Streak* space booster. The previously reported decision has now been confirmed by the British Ministry of Aviation. The *Blue Streak* space booster will be used to orbit European communication satellites and various scientific payloads.

### Overseas Pipeline

SBAC is tightening Britain's ties to the Continent by joining the Association International des Constructeurs de Materiel Aerospacial (AICMA). . . . Rumors continue in Western European capitals that the next Soviet *Vostok* probably will carry more than one cosmonaut. Some of the rumors even have a romantic touch—one of the space voyagers may be a cosmonautess. . . . The British Post Office will cooperate with the U.S. in testing communications satellites.



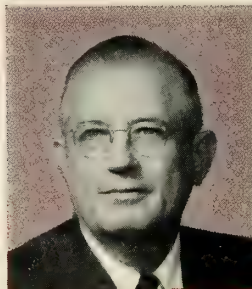
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## Reds Step Nuclear Tests into Multimegaton Class

The Soviets—presumably under simulated combat conditions—began exploding multimegaton nuclear warheads last week in their Barents and Kara sea maneuver area.

In addition, the Soviets said they would begin Sept. 13 launching "more powerful and improved rockets" capable of carrying 100-megaton warheads. The target area was designated as a region 185 by 200 miles some 375 miles south of Johnson Atoll in the Pacific. Test were to continue through Oct. 15.

The step up to multimegaton blasts occurred Sept. 10 in the sixth of the series of tests which began on Sept. 1 with kiloton yields. The Atomic Energy Commission reported that a seventh explosion on Sept. 12 was "on the order of several megatons." On Sept. 13, there were two more firings, both in the low-to-intermediate range.

## Shots of the Week

NASA orbited a *Mercury-Atlas* carrying a robot astronaut Sept. 13. The capsule was recovered (see p. 11).

In a series of military firings, successes were mixed with failures.

- On the plus side, the Air Force successfully orbited *Discoverer XXX* Sept. 12 and planned to recover a capsule from the satellite in about four days time. A capsule was recovered Sept. 1 from *Discoverer XXIX*, which was orbited Aug. 30.

- A Martin *Titan* was fired on a successful 6000-mile flight from the Cape Sept. 6, in a test of its complete system—including the Mark IV re-entry vehicle.

- On Sept. 9, the first full-scale test of a *Nike-Zeus* A-ICBM ended in an explosion shortly after second-stage ignition—and about 6 sec. after launch.

There was conjecture that the failure was caused by either a maneuver of the stage which exceeded design limits or an unprogrammed event which triggered the automatic destruct system. The test was to have ended on a command destruct, but Pacific Missile Range personnel at

Point Mugu said the explosion was not initiated by them. A second *Zeus* test at PMR is expected before the end of the month.

- The *Zeus* launch was followed 25 min. later by the explosion of an *Atlas-Samos* on the pad at PMR's Point Arguello as it was being readied for firing. The Air Force was expected to attempt a backup launch of the picture-taking satellite shortly from an adjacent pad.

- In a cooperative firing with French scientists Sept. 13, NASA loosed sodium vapor at altitudes of 120 and 228 miles to measure atmospheric winds, temperature and density. The launch with a four-stage rocket was from Wallops Island, Va.

Over Edwards AFB, Calif., Sept. 12, Test Pilot Joe Walker flew the *X-15* at about Mach 5 and to an altitude of about 100,000 ft.

## New Strategy Fight

The controversial military strategy of "counterforce" backed by greatly expanded numbers of missiles again became an issue this week as the nation faced increasing Soviet aggressiveness.

A number of key congressmen on both sides of the aisle commented publicly and privately that the United States needed to switch from the defensive to the offensive in the Cold War.

At the same time, Gen. Thomas S. Power, commander of SAC, stated bluntly in a forthcoming book, "Combat Missileman":

"You've got to have a big stick today—a tremendous stick. You're dealing with gangsters. And gangsters don't do anything that there isn't any profit in. You deter through



NIKE-ZEUS on pad at Pt. Mugu awaiting Sept. 9 launching.

fear of consequences. Regardless of how a war starts, the enemy must know that we can destroy his military forces."

However, Administration critics have said repeatedly that the United States must not deploy sufficient missiles and other weapons to guarantee destruction of the Soviet forces under any circumstances.

This is the criticism that is behind much Capitol Hill grumbling about the need for taking the offensive.

## Big Boosters Still Lead

Although NASA is taking a new look at rendezvous techniques as a possible method of beating the Russians to the moon, development of super-boosters still is the odds-on favorite.

New impetus was added to the long-discussed and long-neglected idea of an orbital station as a jump-off site for the lunar expedition in a National Press Club speech last week by Administrator James E. Webb.

Webb said NASA is analyzing the rendezvous capability of the *Saturn* C-3 as an alternate approach to *Nova* for the manned lunar landing. He said this may affect the C-3 configuration. But he made it clear that there is to be no slow-down in devel-



opment of big boosters.

The NASA official also disclosed that NASA is planning a 10-to-12-man orbital space station as a follow-on to the *Apollo* program. Decision whether to go ahead with this is expected by 1965.

### Minuteman Case Contract

The Allison Div. of General Motors received a \$10.935-million contract for first-stage *Minuteman* motor cases from Thiokol Chemical Corp. Deliveries under the production contract will begin this month and continue into the fall of 1962.

### FABMIDS Studies In

The Army is sifting through 10-month feasibility studies on *FABMIDS* (Field Army Ballistic Missile Defense System).

Contractors participating were: The Raytheon Co., Northrop Corp., IBM, Pomona Div. of General Dynamics, Burroughs, Westinghouse, GE, Chrysler, Martin Co., Maxson Electronics Corp., Remington Rand's UNIVAC Div., and Sylvania Electronic Systems.

Other participants: Aeronutronic

Div. of Ford, General Telephone and Electronics Corp., Hughes Aircraft, Goodyear Aircraft, North American Aircraft Co., LeTourneau Inc., and Aerojet-General.

### Scientists Near Moon Pact

A proposal to internationalize the moon and planetary system neared agreement between Soviet and American scientists, meeting at Stowe, Vt.

The plan would call for establishing the same international status as exists for Antarctica.

The meeting, sponsored by the National Academy of Science and The American Academy of Arts and Sciences of Boston, is being attended by seven members of President Kennedy's Science Advisory Board and six members of the ruling body of the Soviet Academy of Science.

Another joint proposal likely to be approved by the conference calls for establishment of a joint Soviet-U.S. program in Space Biology.

### New Team at Lockheed

Lockheed Aircraft Corp. management policies will remain unchanged under the new team which took office last week following the death of

board chairman Robert E. Gross on Sept. 3.

Courtlandt S. Gross, company president for the past five years, succeeds his brother as chairman.

Daniel J. Haughton, executive vice president and former Georgia division manager, was named president.

Haughton, 50, joined Lockheed in 1939, became a vice president in 1952. He was named executive vice president and a corporation director in 1956 following his successful management of the Georgia division.

Dudley E. Brown, vice president finance and a member of Lockheed top management for 20 years, was advanced to a group vice presidency.

### LBJ to Address ARS Meeting

Vice President Lyndon B. Johnson will be the main speaker at the American Rocket Society's "Space Flight Report to the Nation" banquet at the Waldorf-Astoria in New York on Oct. 13.

Other scheduled speakers during the Oct. 9-15 convention include NASA Administrator James E. Webb and Gen. Bernard A. Schriever, chief of the Air Force Systems Command.

### LTV, Thiokol Optimistic

Ling-Temco-Vought and Thiokol Chemical predict sharp rises in earnings for 1961.

LTV forecasts net earnings "substantially better" than the \$1.25 reported for 1960 by predecessor Ling-Temco Electronics.

Thiokol predicts earnings of \$1.2 per share and sales of \$190 million up from \$171.5 million last year.

The company will begin production of *Minuteman* and *Pershing* motors late this year. They are looking for an Eastern U.S. site to develop Project *Nova* boosters. A prerequisite is access to deep water, so the large booster can be floated to Canaveral.

### Strike Ends at Lowry

Union building craftsmen went back to work after a four-day strike at a *Titan* site at Lowry AFB, Colorado, ending the first major missile-bus walkout since the President set up the Missile Sites Labor Relations Committee.

The union decided to resume working pending Commission action on its dispute with the AMCO Federation of Houston.



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Future space programs will require even more advanced support systems with unique opportunities for men who can meet the challenges of this rapidly growing field of technology.



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Design and development of ground electronic systems, through the RF spectrum, for application in the support system of the re-entry or space vehicle. Requires BSEE, 6 years experience with background in such fields as communications, telemetry or radar.

### ENGINEERS — GROUND & SPACE SUPPORT APPLICATION

To provide technical direction in the preliminary design involved in the development of ground and space support systems. BS plus 8 years experience with knowledge in electronics/electro-mechanical fields including monitor control and instrumentation system development.

### DIGITAL COMPONENT DESIGN ENGINEERS

Design, development and evaluation of digital input/output devices for use in automatic checkout equipment. Requires EE with 3-5 years experience, including background in data processing input/output equipment or transistorized logic design.

### ADVANCED ENGINEER MECHANICAL ELECTRO- MECHANICAL IMPLEMENTATION. TECHNOLOGY

To advise and consult with mechanical and electro-mechanical design groups in incorporation of advanced implementation techniques in ground and space support components and systems. Requires minimum of MSME, 10 years experience with broad technical background.

### ELECTRO-MECHANICAL ENGINEERS

Design and development of electro-mechanical components and systems for ground and space support systems. BSME with 6 years of experience including background in servo systems and electro-mechanical instrumentation.

### CONTAINER & PACKAGE DEVELOPMENT ENGINEERS

Design and development of metal and non-metal reusable containers for shipping, storage and environmental control of large, fragile components and equipment. Requires BSME with container design, background and familiarity with military packaging specifications.

### SYSTEMS ANALYSIS ENGINEERS

Design analysis of ground and space support equipment and systems. Requires EE or ME with experience in electronics/electro-mechanical field.

### CRYOGENICS ENGINEER

Cryogenic design to include liquid oxygen, nitrogen and helium manufacturing storage or transfer systems, cryogenic cooling systems, and heat exchanger design. Requires ME or Physics degree with 2-5 years experience.

### LOGIC DESIGN ENGINEERS

Design and development of logic sub-assemblies for a large scale digital check-out system. Requires BSEE, 3-5 years experience and background in computer logic design emphasizing transistorized switching circuit techniques.

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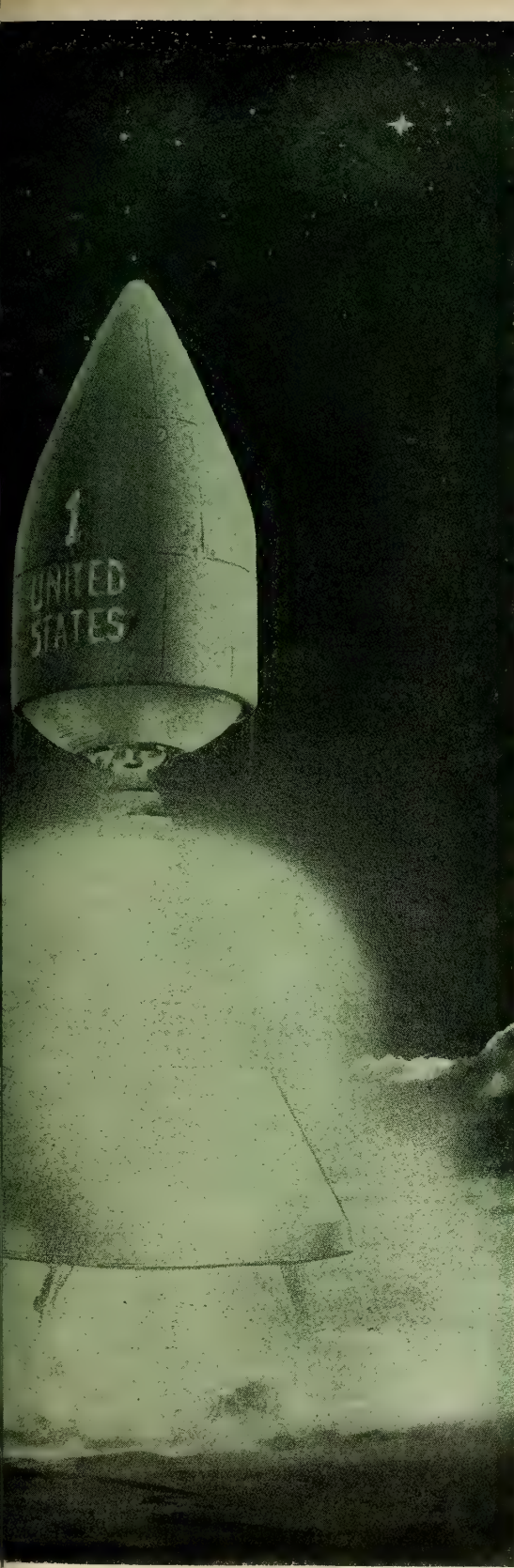


*Missiles and Rockets Fourth Annual . . .*

**Ground  
Support  
Equipment** *Special Issue*







by James Trainor

## ***GSE Headaches of the '60s***

Man-to-Moon demands, changing missile picture carve support industry into brand-new pattern

HARSH NEW challenges are reshaping the great, amorphous support equipment industry into two sharply distinct forms.

Until now, the lines for support of missile and space systems have frequently crossed. However, with the decision to race Russia to the moon, the paths are separating. From now on there will be GSE tailored expressly for missiles and GSE tailored expressly for space.

On one hand, the vast U.S. lunar program is posing a demand for the development of ground systems unprecedented in size and complexity.

On the other hand, industry is confronted by the resumption of nuclear testing, which is expected to bring into being whole new families of small, highly mobile missiles. Thus, the essential difference comes down to one of size.

There now seems to be almost universal acceptance of the inalterable fact that GSE is as important as the missile or space vehicle it is to support—and, hence, design and development of GSE must be concurrent. NASA Administrator James E. Webb underscored this point last week, declaring that facilities are the “pacing item” in the *Apollo* lunar program, rather than the boosters or spacecraft.

These are but some of the prevailing currents apparent in the survey of selected missile and space GSE areas in the following pages.

*(Continued on next page)*



*How will the big and little problems be solved to insure the success of missile and space programs? Here's the way some experts see the future shaping up:*

In the space program, the enormous height and girth of the *Nova* and *Saturn* boosters create GSE demands for which there is little experience. While among the more sophisticated lunar and planetary instrumented probes—like *Prospector* and *Mariner*—there is a requirement for more specialized GSE, particularly checkout and simulation equipment, to enable them to meet a narrow firing window.

Perhaps the only area of support equipment that is not a matter of serious concern is the fueling equipment. The consensus seems to be that larger pumps, greater launch-site cryogenic storage facilities and increased propellant manufacture at Cape Canaveral will be sufficient to meet the support requirements of *Saturn*, or even *Nova*, launchings.

However, this optimism does not extend to nuclear rockets.

The gantry—long an essential piece of GSE—is un-

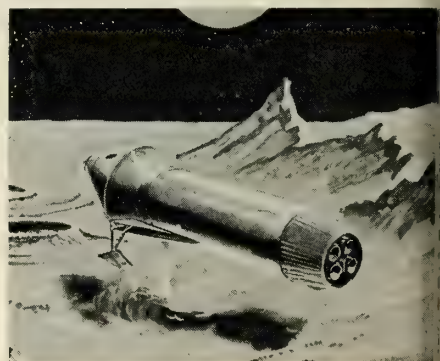
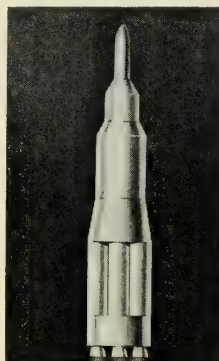
lated a requirement for the *Apollo* spacecraft that every component and every system have a *known* lifetime to insure its functioning throughout the entire lunar landing and takeoff mission.

These then are some of the challenges facing the designers of support equipment for space systems. However, this is only one side of the coin. Equally challenging problems face designers of missile support equipment.

Hardening of missile sites—once considered a closed issue—may have to be re-evaluated in light of the Soviet threat to build a 100 megaton bomb. Such a second look would probably place added support requirements on the hardened systems. Greater resistance to overpressures will also have to be considered for the command and control centers which the Administration considers such an essential part of our defense posture.

The greater emphasis in the Defense Department on getting more defense per dollar has given new life to reliability and value analysis programs in industry. The majority of the firms queried by M/R said that reducing the cost of GSE across the board and insuring longer life and lower component failure rates were primary considerations in their planning.

Mobility—long a preserve of the Army—is getting



SIZE OF THE PROBLEM . . . in warheads . . . boosters . . . lunar takeoff

dergoing serious reappraisal. In fact, for the *Saturn C-3* which is expected to have a relatively high rate of fire, it is to be eliminated and replaced by a simple umbilical-servicing mast.

For *Nova*, the massive service structure may prove to be too heavy to move and so the space vehicle may be fired through it or the structure may be folded back like a giant clamshell.

Checkout procedures are also undergoing re-evaluation. The problem: to checkout the myriad of components on a *Nova* vehicle in approximately one-sixth the time required to check a standard *Redstone*. The hoped-for solution: greater reliance on automatic, high-speed data processing equipment, increased use of digital links to the blockhouse and integration of telemetry packages into the checkout procedures.

Azimuth alignment of these large spacecraft is also a challenge. The sway for a vehicle of the *Nova's* size may require tracking equipment for the alignment theodolite. Atmospheric effects and distance from the target also pose problems for the alignment devices.

There are, of course, many other problems and challenges in spacecraft GSE. However, none is more critical than lunar GSE. For, in effect, one authority has stipu-

lated a requirement for the *Apollo* spacecraft that every component and every system have a *known* lifetime to insure its functioning throughout the entire lunar landing and takeoff mission.

Lightweight, mobile systems—capable of surviving in any environment—are still unachieved goals of the Army. However, reaction time and “wooden round checkout are also areas of immediate concern. The tendency for an Army system—particularly its GSE—to become heavier as it moves through the development cycle is a trend which the Army is still trying to reverse.

These then are some of the challenges that must be faced if effective support equipment for this country's missile and space programs is to be developed. It is not a complete list, but it is representative of the areas of concern to the Defense Department, NASA and industry.

The very fact that, during the next five years, GSE will consume 30-50% of the total systems cost has accentuated the concern felt by many that GSE can no longer be neglected or treated as a step-child. And this realization—even in the face of the problems to be solved—is the most encouraging aspect of the 1961 Ground Support Equipment picture.

# Events Forcing Big Surge in Spending

Commitment to moon race, bolstering of missile arsenal, demand for extra hardening of ICBM sites likely to push support costs far beyond current \$4-6 billion a year

by James Baar

A TRIPLE WALLOP—the new U.S. drive to the moon, the Berlin crisis and the resumption of nuclear testing—is expected to force the currently large demand for ground support equipment to rise steeply over the next 18 months.

The new demand will more than wipe out the slump in the ground equipment market previously forecast because of the “buy out” of the big *Atlas* and *Titan* ICBM systems.

The GSE market—or, in the latest Air Force terminology, the AGE (aero-space-ground equipment) market—is as difficult as ever to tag with a price because of the wide variations in what different Defense Department and NASA budgets include. However, depending on what is included, this market is running from about \$4 billion to \$5 billion annually, and is rising.

The key areas where this rise is occurring are:

- **The space program**—A nearly \$1-billion expansion program at Cape Canaveral alone is getting under way. Telemetry, more test, tracking and launch facilities are expected to be built at other U.S. ranges and industrial sites and at stations around the earth. And the requirements for a wide variety of new space support equipment are just being written.

- **The missile program**—Procurement of tactical systems is already increasing and is expected to increase considerably more in the FY '63 defense budget. Also, one or more new strategic missile systems with special GSE requirements are expected to be started.

- **The hardened sites program**—The development of huge nuclear warheads by Russia is expected to force greater hardening of missile sites, command and control centers and communication systems.

The magnitude of the cost of the ground support equipment for the space program is clearly indicated in the plans announced to date for Cape Canaveral.

At present, six new launching complexes for superboosters are planned by NASA. The estimated cost of building and equipping them, along with industrial and cryogenic facilities, is about \$800 million. That means the launching pads including all auxiliary facilities will cost about \$130 million each.

By way of comparison, the appropriations for construction of facilities for the *Saturn* booster program through FY '62 total \$86.2 million; the cost of building and equipping a 12-missile *Atlas* squadron is about \$152 million.

The expansion at the Cape is clearly only the beginning of the investment in support equipment in the drive to the moon. Some estimates put the annual expenditure by NASA for procurement and R&D of support equipment and facilities at well over \$1 billion by FY '64.

In the missile program, the full effect of the Berlin military buildup on procurement is yet to be felt.

For the first time, the Army is expected to receive authority for large scale procurement of new tactical missile systems. Such new missiles as the *Martin Pershing* and *Sperry Sergeant* involve large quantities of support equipment.

Moreover, the Berlin crisis and new Soviet nuclear tests are putting new pressure behind Army arguments for the deployment of the *Nike-Zeus* anti-missile missile. The cost of deployment and production of *Zeus* is estimated conservatively at about \$7.5 billion, much of it GSE.

The proof-of-the-pudding tests for the big Western Electric missile are scheduled for early next year in the mid-Pacific. The chances of a decision to begin production next year are now considered to be good.

The Navy also is expanding its procurement of tactical missiles and the addition of considerably more missile warships with their large quantities of support equipment is expected.

Whether the Navy will build more

*Polaris* submarines beyond the 29 currently authorized has yet to be decided. However, pressure from Congress seems to make an increase in the fleet to at least 39 to 45 inevitable.

The latest-class *Polaris* submarines are costing \$116.2 million each. About \$39 million of this is support equipment.

In the field of R&D, highly mobile strategic missiles are expected to be made increasingly attractive by the improvements in nuclear warheads which U.S. physicists anticipate will result from renewed nuclear testing.

These missiles probably will be deployed on some form of truck or spacecraft. Very new ground and space support equipment will necessarily have to be developed for such systems.

Also, new support is expected for resuming the rapid development of the train-launched *Minuteman* ICBM. Some estimates of the cost of support equipment for the deployment of a force of 200 mobile *Minutemen* run about \$1 billion.

Probably it is in the U.S. hardened sites programs that the announced Soviet plan to develop 100-megaton nuclear warheads will have one of the most profound effects.

Air Force plans call for hardening fixed *Minuteman* sites to about 200 psi. These plans were formulated on the basis that the Russians would attack the sites with warheads in the 10 megaton class.

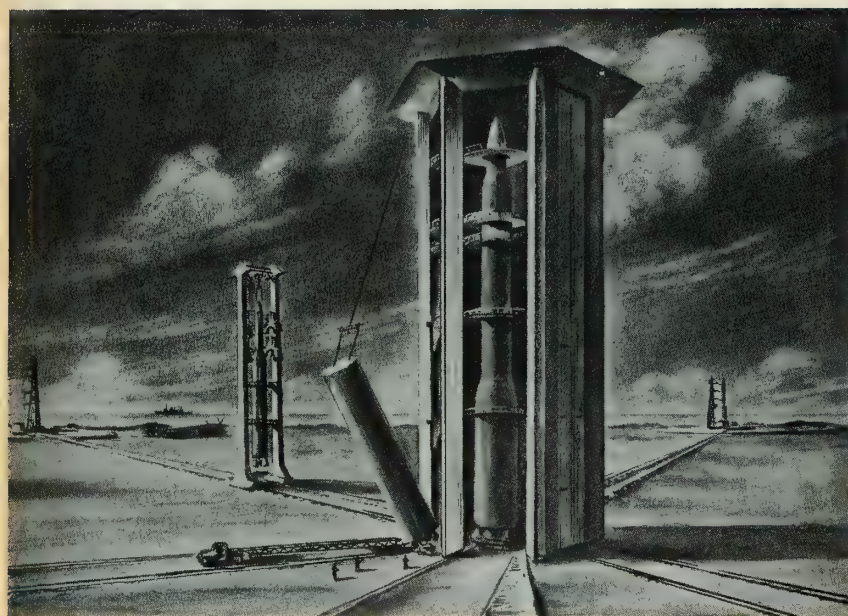
By using 100-megaton warheads, the Soviets could significantly decrease the number of missiles needed to have a high probability of knocking out the fixed *Minuteman* force. Therefore, to maintain the same survivability ratio the sites would have to be made much harder—possibly to 500 or 1000 psi or more. Such a move would cause costs to increase considerably.

The GSE market is in a state of great change and adjustment to new developments. Almost all changes and adjustments point toward expansion. ♦



# Apollo: Giant Equipment, Problems

*Manned space-flight effort introduces entirely new parameters in transportation, assembly and checkout*



*SPACE VEHICLES of Saturn C-3 class will be assembled, checked out and serviced in huge structures like the one shown, then will move by rail-canal system to the launch pad*

ALTHOUGH STILL to be finalized, the picture that is emerging of the equipment required to support NASA's manned space flight program staggers the imagination. In sheer size and complexity, this space GSE outstrips anything that has been done in this country's missile and space programs to date.

For example, the gantry for the *Nova* vehicle will be so massive that it most likely cannot be moved away from the missile before firing. This unique limitation has forced NASA to talk about firing the huge *Nova* vehicle through the gantry or hinging the servicing structure so that it can be folded back like a clam-shell before liftoff. Which approach will finally be selected, has not as yet been decided. However, this is illustrative of the unique problems of GSE for the *Apollo* program.

• **Which way to the pad?**—One of the first considerations facing GSE designers is the simple question of how do you transport the out-size boosters, upper stages and the *Apollo* spacecraft to the launch site? Everything from on-site manufacture and assembly to lighter-than-air craft has been proposed.

The most likely method—and the only one being seriously considered by NASA—is the tried and true barge transport system used with *Saturn*. Using this system, according to NASA, the only new requirement will be for larger and larger barges to handle the *Saturn C-3* and the *Nova*.

The determining factor, however, will be the decision on whether direct or orbital rendezvous flight will be used for the lunar landing. (NASA officials concede that direct flight is the odds-on favorite.) The goal of either approach, however, is to achieve the shortest possible shipping time.

Therefore, in addition to the barge system, studies are being conducted to determine whether a modified C-130 aircraft might be used or perhaps an

entirely new aircraft developed. Running a poor third in the transportation race is the lighter-than-air proposal.

The *Apollo* spacecraft itself will have to live in a protected environment from the time it leaves the factory until it is launched. Even after being placed in the missile, the craft will be shrouded to protect it from corrosion and to provide it with conditioned air.

• **Assembly: Saturn C-3**—Once all of the components reach Cape Canaveral the C-3 will be assembled and checked out vertically well away from the launch pad. The assembly and checkout building—the most accurate and up-to-date illustration of which accompanies this article—will also be a unique structure. With a ceiling over 100 ft. from the ground, it will provide many of the functions previously handled by the gantry. Assembly, checkout and servicing—all conducted in this facility—eliminate the need for anything but a simple umbilical-servicing mast at the launch site.

Once checked out and ready for firing, the C-3—still in the vertical—will be transported from the building to the launch pad by a combination canal-rail system. The vehicle moves on a specially designed "trolley car."

The main advantage of the rail canal system—rather than a straight rail approach—is that the canal enables the vehicle to be more easily positioned and also eases the possibility of rail deformation.

Although the vertical assembly and checkout approach costs more initially for the construction of facilities, it has two main advantages over the more conventional procedures: It gives a higher rate of fire capability in that launch pads are not tied up with one vehicle for long periods of time and it eases the vehicle design problems by simplifying the requirements for lifting points. Also, the vehicle can be pulled back into a completely protected area in approximately two hours.

• **Assembly: Nova**—The tremendous size of the *Nova* precludes any use of a system such as that described above. This vehicle will necessarily be assembled and checked out on its launch pad. However, due to the lower rates of fire contemplated for *Nova*, this does not impose a penalty on the use of the launch facilities.

The gantry—weighing some 3500-4000 tons—will be completely enclosed and will stand approximately 435 feet high and be 120 feet wide at the base. A semimonocoque constructed, the twin towers would be topped by a head which supports a mobile crane for flight vehicle assembly, checkout and trans-

port. The towers would contain work areas for most of the checkout and servicing gear required up to the time the vehicle is placed on the launch pad and the umbilical tower connected.

In this connection, studies are being conducted by NASA to determine the gantry requirements for both liquid and solid propellant boosters. It is essential that the differences between the two be delineated, as one NASA official put it, because the country cannot afford to build separate facilities for each.

The umbilical tower for last-minute servicing of the vehicle could consist of a standard-type crane above a fixed tower. The crane boom would be used to lean into the vehicle's upper stages with access to the vehicle by means of adjustable access platforms. The tower would also contain an elevator to lift the flight crew to the *Apollo* command capsule during the countdown.

#### • Computers and countdowns—

Once a vehicle is on the launch pad, the main consideration will be to launch it as soon as possible. The long, tedious countdowns of the past will be eliminated by a greater reliance on automatic data processing equipment. However, NASA is not ready to rely completely on computer checkout, rather it is aiming at an optimum man-machine relationship to provide rapid, fail-safe checkout.

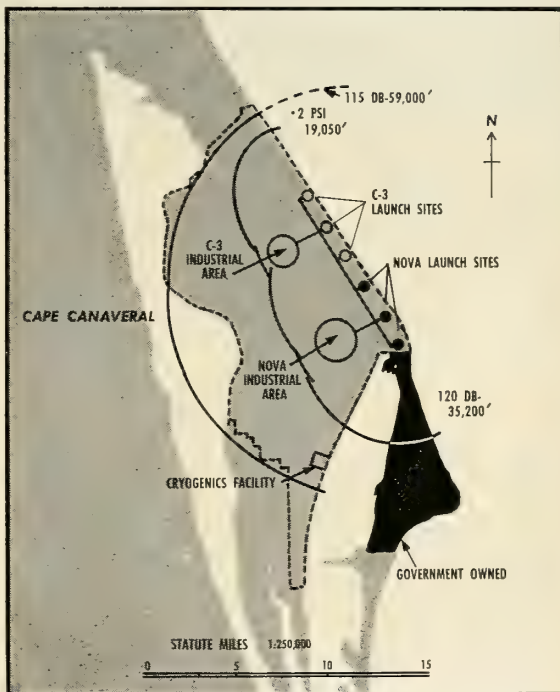
Whatever the final breakdown, however, the checkout system will have to provide a high degree of truthfulness in addition to cataloguing statistical data on the myriad of components in the *Nova* and C-3 vehicles.

The fundamental difference between the large space vehicle and its more parochial cousins will be the integration of digital and telemetry-package outputs into the checkout procedures. Since the blockhouses for both the *Nova* and the C-3 are expected to be located at some distance from the launch pad, the use of digital data rather than analog

will eliminate the problems inherent in long distance transmission of the analog data.

However, the digital approach will necessitate a series of conversions from analog signals in the missile to digital and perhaps back to analog at the blockhouse. The use of telemetry packages for checkout seems to spring from the attitude that the equipment is there anyway and it can do the job so why not use it and save both time and equipment.

Perhaps the only problem concerning support equipment for space which



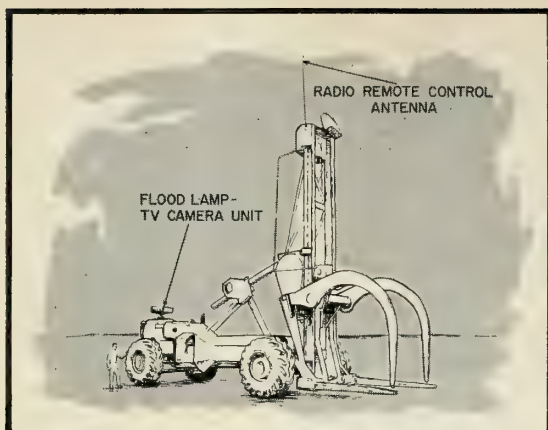
MAP of space vehicle launch complex. Note that the industrial complex will be located well within the 120-db line—a noise level that could cause structural problems.

doesn't have designers worried is fueling. There is a consensus among those most concerned with the lunar program that the fueling problem will entail little more than larger pumps and higher pumping rates.

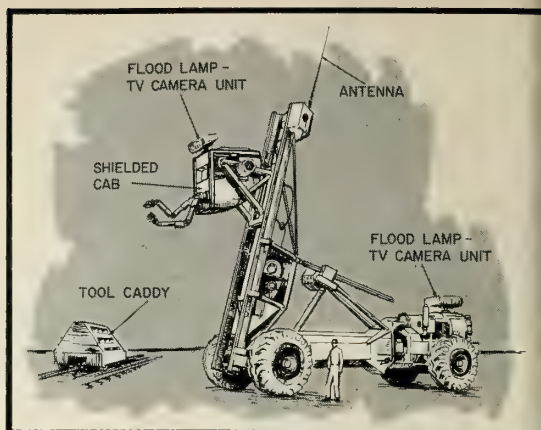
In addition, they feel that a high-output cryogenics facility will have to be built at Canaveral to support the space launches. The liquid oxygen, hydrogen and nitrogen would be manufactured at this facility and truck-transported to large storage tanks at the launch site. With the high firing rates predicted by NASA for the C-3, this belies the need for a facility producing many tons a day of the highly volatile

(Continued on page 68)





**FORKMAN.** Large engine sections could be handled easily with this modified fork lift truck. AMF has no firm idea as to the number of types of remote vehicles needed at a launch or test site. Its pessimistic attitude is evident.



**HANDYMAN AND TOOL CADDY.** Off-road capability is combined with the shielded cab concept to bring a man as close to work as possible. The basic vehicle is very similar to conventional heavy construction units currently in use.

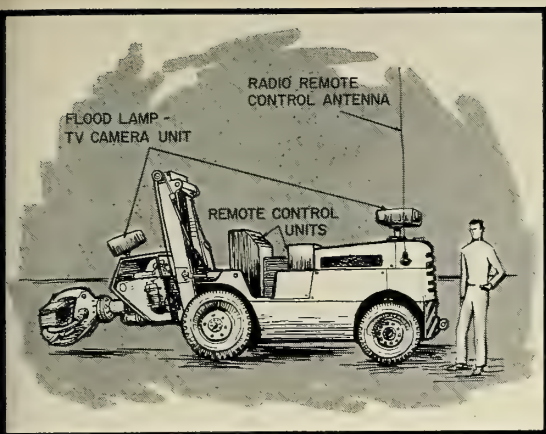
**GSE** SPACE

## Nuclear Rocketry Hopes Hobbled

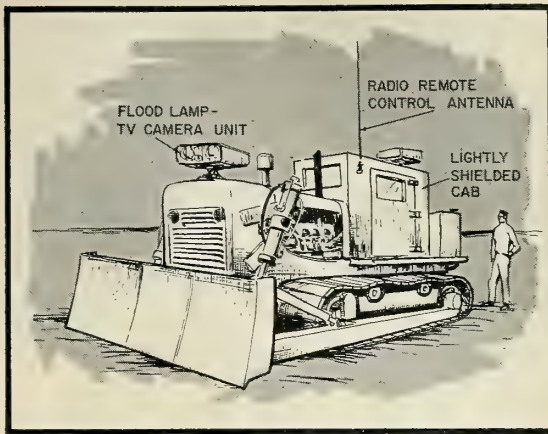
**Years of experience with reactor equipment have left AMF Atomics pessimistic about prospects—longer lead time called vital**

**MODELS ILLUSTRATE** the versatility of mobile manned shielded cab. Unit at right could be used to separate engine components in the MAD building.





**LAWMAN.** Heavy-duty capability in lifting and positioning radioactive sections too large or bulky for smaller handling units is afforded by this mobile vehicle. Like all the remote equipment, the unit can be manually operated.



**SANDMAN.** One of the all-purpose vehicles maintained in case of an accident. Bulldozer could shove radioactive rubble to a safe site, or possibly bury it until it was "cold" enough to permit manned inspection and recovery.

# Limitations of Remote Handling

By John F. Judge

GREENWICH, CONN.—Unless there is a complete reversal of the conventional ground support equipment approach, some experts fear the nuclear engine could easily be designed right out of the U.S. rocket program.

The key problem: remote handling.

The engine must be designed from the start for remote assembly, inspection and checkout—something brand new in rocket technology. If this is not done, then the cost of the program as the launch date approaches will be prohibitive.

Removing man from such an operation raises a host of problems. AMF Atomic, a firm long skilled in reactor technology, is attempting to reverse the process. Years of designing and building remote-handling equipment for reactors has brought home the fact that no mechanical means can really replace a man's hands.

• **Belly up to work**—The basic note of the AMF nuclear support approach is to get the man as close to the work as possible. Even then there will be a need for remote operations. Thus, if an engine is not designed with this in mind it becomes a one-shot affair, incapable of check-out corrections.

H. C. Neale, Engineering Manager,

says the engineering aspects of Nuclear Support Equipment (NSE) are grounded in current nuclear technology but advanced engine concepts will require NSE beyond the present state of the art in machine development.

Neale and his associates have found that the more complex a remote handling operation becomes, the less efficient it is in comparison with a man. "There are innumerable little things in the simple turning of a nut that crop up in attempting to mechanize the job," he says. Not the least of which is visibility.

This leads to one of the commandments in remote operations—if it cannot be seen, it cannot be done. And TV is a miserable substitute for the eye.

• **Nuclear background**—AMF Atomic is a world leader in the research reactor field. In 1942 the firm got its feet wet machining uranium for the legendary Manhattan Project. Special components were built for Hanford and Oak Ridge and the responsibility for all the machinery and handling equipment at the Savannah River heavy-water production reactor lay with the firm. Most of this equipment is still at work more than 10 years later.

The long association with things nuclear has given AMF more than a manufacturing capability—it created an atmosphere of pessimism. NSE people at

AMF are firm adherents of "Murphy's Law." They are convinced that if anything can go wrong, it will—and at the least desirable time.

This philosophy is most apparent in their NSE plans. One avenue is never enough, there must three or more for every minute segment of the job. They expect the worst and design for it.

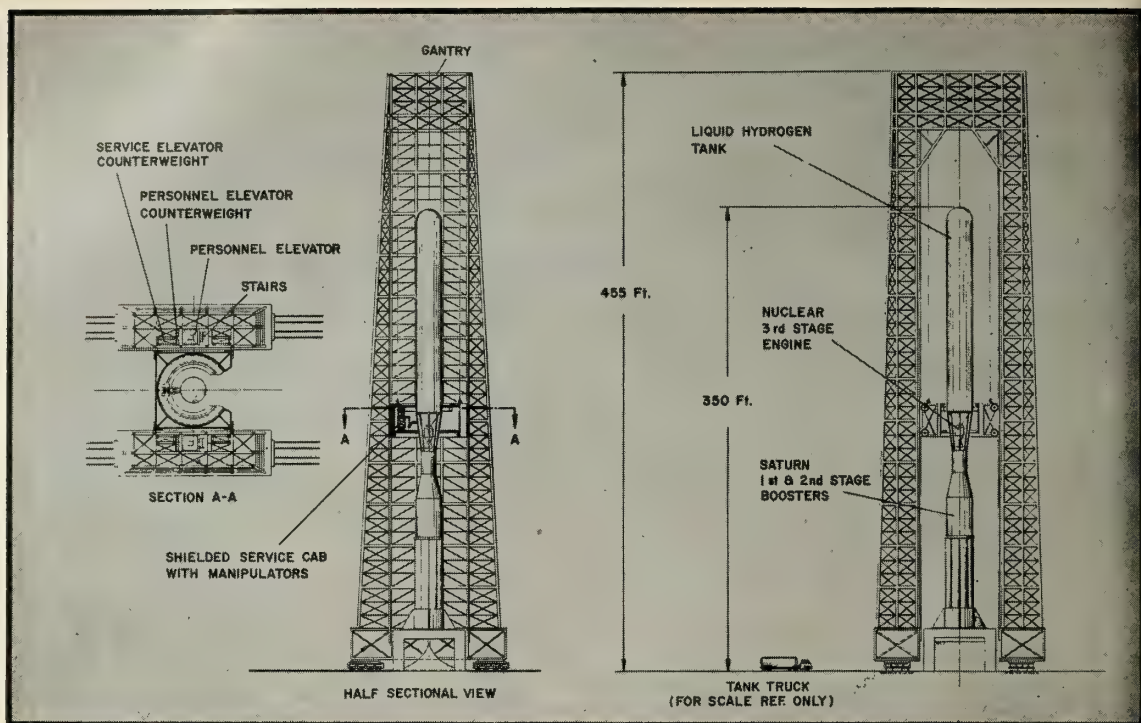
The firm has active plans for a motor assembly and disassembly (MAD) building capable of handling current and future generations of nuclear engines. The facility is designed to handle the entire engine, break it down into major components and hustle each of these off into small hot rooms for detailed remote work.

The building is connected with various test stands by a remotely operated railway. Each handling structure is designed to expand with the different requirements of an active engine program, and all can cluster for a task.

Launch NSE is somewhat more complex. AMF spokesman say that the engines will eventually have to be assembled at the pad. This involves some fairly large and complex facilities.

Mobile handling equipment will be a necessity. Neale says the vehicles themselves pose no major problems. Most of them are familiar sights on heavy construction projects. It's the





AMF INCLUDES a shielded service cab in the gantry complex for a nuclear-staged rocket. The cab would have direct vision and television capabilities, together with remote manipulators. Direct observation is strongly preferred.

addition of the remote handling apparatus that is tricky.

One AMF concept in this area that drew wide interest is a general-purpose, manned, shielded vehicle. Completely mobile, the unit can handle a host of functions at test areas and on the launching pad itself. Again, it brings

the man right up to the work.

AMF spokesmen expect the realities of nuclear engines as part of space missions will involve many things currently unforeseeable. The most difficult aspect of their job is simply that the engines do not exist. Plans must be predicated on projected needs—requirements that

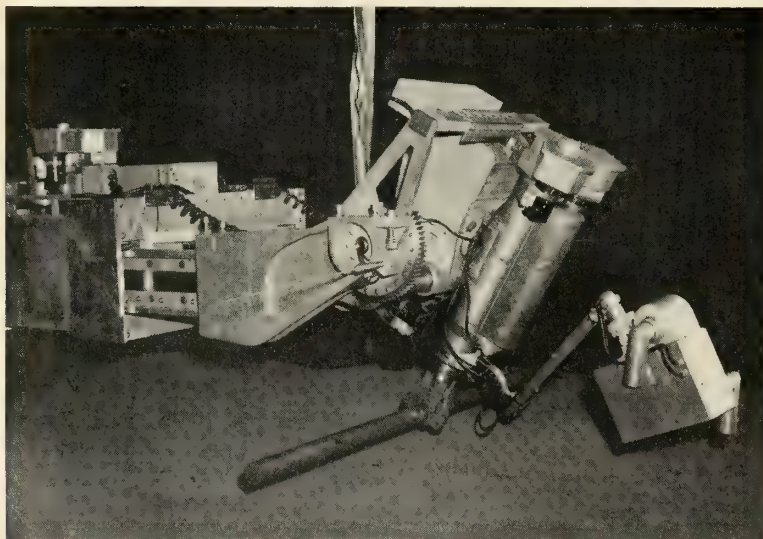
will change and often.

• **Guessable inputs**—The engine are so expensive that recovery methods will probably be perfected; NSE projections must take this into account. An operational rocket with a nuclear upper stage will probably have some means of ascertaining the reactor's readiness during the final countdown. This might involve running it at some low percentage of its total power. Instrument limitations currently peg this at about 0.5% power. Another factor in NSE projections becomes evident.

Applying Murphy's Law to launch operations leads to the inclusion of an other capacity in ground operations. A "disaster" crew with proper equipment will also be needed. Such a unit would have the training and means to handle every conceivable type of mishap on the pad and after launch.

Nuclear support does not end with launch. There will be a demand for space-platform remote handling, testing, and inspection. Nuclear engines will give the U.S. a lunar landing capability, thus extending the NSE requirement to the moon. Exploration sites will use nuclear power and wherever a reactor goes, so does a certain amount of remote handling equipment.

AMF is sure of one point—engine are not the only long-lead item in a nuclear rocket program.



THIS REMOTE HANDLING DEVICE has been in service at the Savannah River reactor for more than 10 years. As one AMF engineer cracked, "It's not streamlined because it doesn't move fast." The unit illustrates the complexities of a manipulator.

# Refining Azimuth Heading Accuracy

*Optical alignment systems are being made more and more sophisticated for seconds-of-arc demands of future moon firings*

by George Mrus\*

PERHAPS the most critical element in accurately aligning space vehicles to shoot the moon is correct azimuth heading.

Aiming a space vehicle involves seconds-of-arc pointing accuracy—far greater than that required for missiles traveling short distances. And new electro-optical alignment instruments have been developed to meet this increased accuracy requirement.

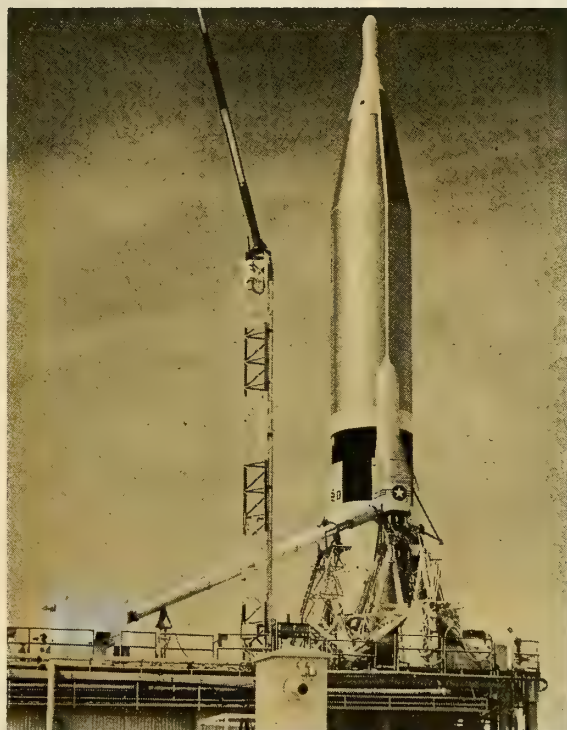
The inertial guidance system depends upon having the three axes space-stabilized prior to launch, fortunately gravity automatically provides the capability of aligning the two horizontal axes with equipment built into the alignment platform.

However, there is no simple automatic heading device. Azimuth alignment must be performed with a reference external to the missile—one being *Polaris*. Sightings can be taken on *Polaris* at the time of alignment, or bench marks previously located from *Polaris* can provide references from which the true azimuth heading can be determined prior to launch.

Another method of providing a correct azimuth heading reference is through the use of the North-Seeking Gyro, which is rapidly increasing in accuracy. Both of these methods supply only bench marks and require a device to transfer the reference from the bench marks to the platform.

\*Mr. Mrus is with the Electro-Optical Division of the Perkin-Elmer Corp.

missiles and rockets, September 18, 1961



ATLAS ON LAUNCH PAD with azimuth alignment equipment developed by Arma to overcome early problem of "shimmer."

Gyro-Compassing methods are being investigated with considerable optimism. This technique is a mode of operation of the inertial system itself which requires no external azimuth reference transfer. However, in its present state of development Gyro-Compassing manifests many problems; it will be some time before inertial guidance systems employ it for azimuth alignment.

Today, optical alignment systems are becoming extremely sophisticated. The importance of missile alignment in the future will also be very great. The pointing errors are quite significant when terrestrial distances are long.

A 20-second azimuth error in a 1500-mile flight would give an equivalent 0.15-mile target error, and when discussing celestial distances the errors become astronomical. For instance, the moon is approximately 248,000 miles from the earth; a 20-second error at this distance would result in a 25-mile error at the moon's surface.

• **Large vehicle problems**—Current plans for launching large space probes at Cape Canaveral present special alignment problems to the electro-optical engineer. Standing on their bases, subject to the atmosphere and various perturbations, the unprotected large space vehicles particularly complicate the problems associated with the transfer of the azimuth heading.

The alignment geometry associated with the large space probes is shown in the illustration on page 24. The vehicle, as shown, rests with its base on the launch pad at ground level and with the inertial system located

in the uppermost stage. The theodolite—installed on a base near ground level—projects a beam of collimated light at the correct angle to the reflecting prism mounted on the stable platform in the missile.

To achieve the greatest accuracy in azimuth transfer, the theodolite should ideally be located at the same height as the platform prism, since azimuth accuracy decreases as the sight elevation increases. However, the sheer size of the space probes renders this impractical.

Therefore, a compromise between the distance from the vehicle and sight



# Atmosphere makes most trouble . . .

angle is necessary. Since the explosive hazard also dictates that the theodolite be located some distance away, a 30 degree angle was chosen as the best compromise.

To illustrate the magnitude of the problem, a 200-ft. *Saturn* vehicle would have an estimated sway of anywhere up to  $\pm 10$  feet and the theodolite—located 350 feet from the base of the missile—would have a slant range line of sight of 400 feet. Comparable statistics for a 300-400 ft. *Nova* vehicle read like this: sway—unknown, distance of theodolite from base of the missile—500 to 700 feet giving a slant range of 600 to 800 feet.

• **Alignment geometry**—It is important to appreciate that the basic geometrical facts of optical alignment are necessary to the operation of inertial platform alignment. The present state of development of alignment instrumentation must now contend with the new problems fostered by the large space probes.

Alignment instrumentation must conform to the requirements of the vehicle and inertial system designers. For example, the more sophisticated inertial systems have an attendant decrease in physical size which limits the size of the reflecting prism. An early system used a 6 in. x 3 in. reflector prism at distances up to 1000 feet. Today, the reflectors on some platforms are smaller than 1 in. x 1 in. with the requirement for monitoring at fairly long ranges.

As long as the alignment theodolite is located a short distance from this small reflector, many of the alignment problems are eliminated. However, as

discussed previously, this is not always possible or desirable.

• **Atmospheric problems**—More fundamental alignment problems, however, are those of the atmosphere. Atmospheric perturbations can affect both the alignment accuracy and the theodolite ability to supply an azimuth reference to the vehicle platform. Several of the more important problems in this area are:

—“Seeing” the prism due to problems attributable to light attenuation and forward scattering.

—Back-scattering resulting from haze and fog which not only attenuates the light but can prevent azimuth reference transfer by raising the noise level at the theodolite.

—Finally and most important, “shimmer” or atmospheric boil.

Shimmer is due to the thermocurrents of radiance which are generated by energy from the sun causing the density of the atmosphere to vary. The shimmer problem—most pronounced on a sunny day when the optical line of sight passes close to air, earth, sand and pavement—can be minimized by aligning the missile at night when the ground radiance is lowest or mounting the theodolite above the ground to place it above the maximum turbulent areas of the atmosphere.

Another interesting technique for reducing effects of air turbulence was that used by the Arma Division of American Bosch Arma Corp. at Cape Canaveral. Arma used a double-walled light beam tunnel between the alignment theodolite and the reflector in the *Atlas* ICBM.

By air-conditioning the area between the inner and outer tube, a uniform temperature gradient was achieved in the inner tube and prevented thermal currents from disturbing the line of sight. Since the reflector is located near the base of the missile and only required a tunnel about 50 ft. long, this system worked well.

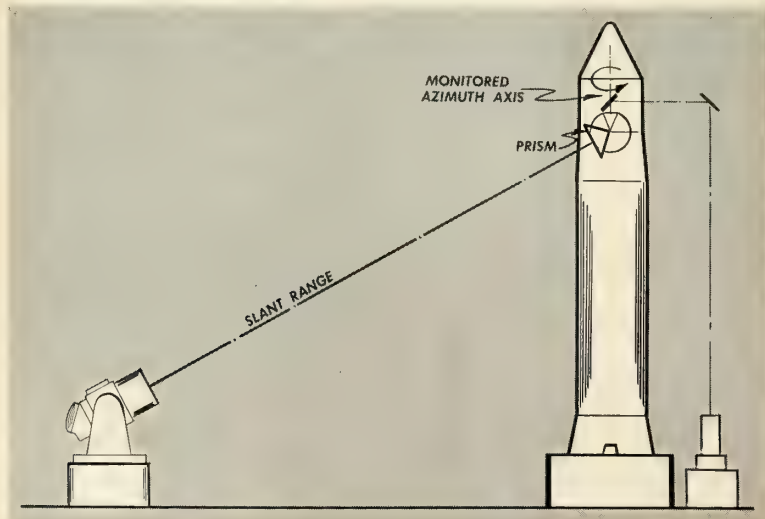
Since shimmer causes the reflected collimated light beam to oscillate back and forth more or less equally, it decreases the instrument accuracy and causes the noise level of the theodolite to increase. The average direction of the beam, however, still correctly represents the line of sight—hence the azimuth heading.

• **Space probe alignment**—Assuming that all the atmospheric conditions have been minimized or compensated for, a correct azimuth line-of-sight still must be established by the alignment theodolite. The theodolite projects a beam of collimated light to the vehicle reference prism. The vehicle must be aligned so that the reflector is located in the collimated beam of light. In addition, the reflector must send light back into the theodolite.

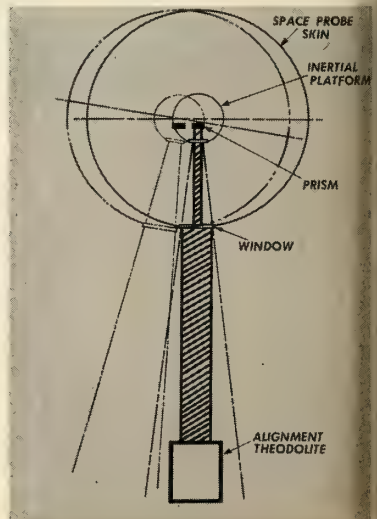
In the case of the new space probes—basically very tall, extremely slender, thin-wall tubes—the alignment problem is very difficult. If these vehicles were strictly thin-wall tubes, the various motions that could take place would be predictable. Unfortunately, this is not so. An unsheltered, erected vehicle exposed to the sun will bend away from the sun. In addition, a twist or torsion of the entire vehicle occurs. Added to this is the vehicle sway caused by the wind, which can only be estimated.

The large space probes create addi-

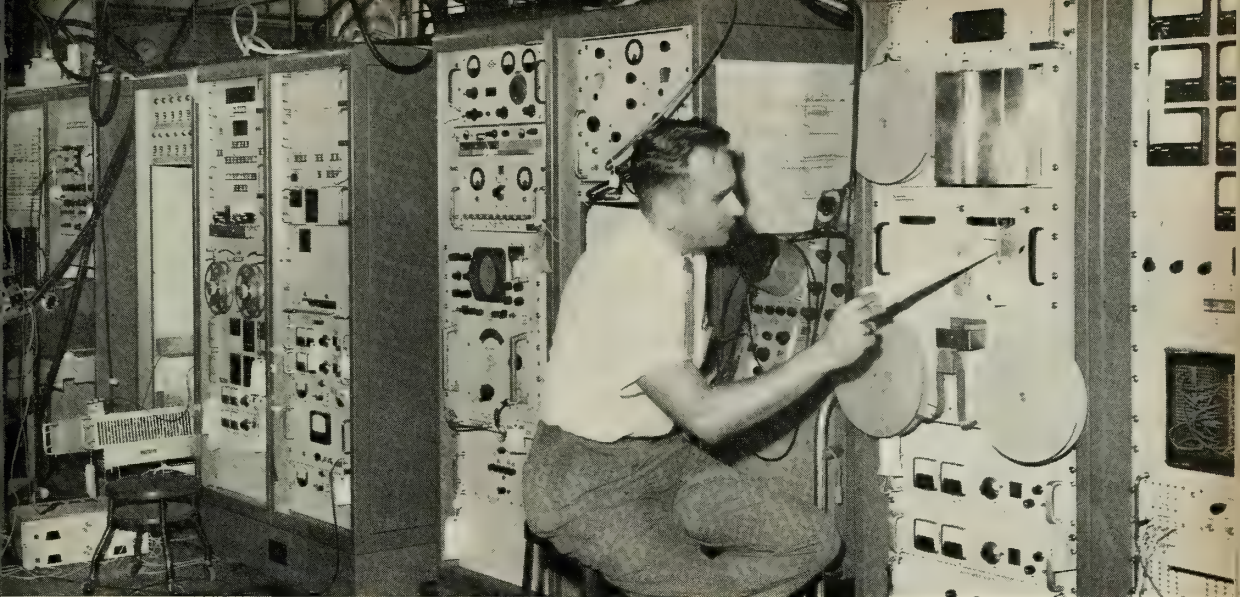
(Continued on page 67)



PRISM MUST be acquired on inertial platform at slant range up to 800 feet.



SWAY could fully vignette prism.



**AUTOMATIC TEST SYSTEM** for use with Lockheed's new high-vacuum orbital simulator undergoes final checkout before it is installed. Developed by RCA, the system (called APATS)

will be employed to check out electronic instruments for future space vehicles in a realistic environment.

A NEW CHECKOUT system which eliminates the need for specialized test equipment will soon be employed for realistic testing of electronic packages in a space environment.

Built by Radio Corporation of America in Camden, N.J., it will be used with a high-vacuum orbital simulator now being installed at Lockheed Missiles & Space Co. in Sunnyvale, Calif.

The rapidly growing number of space missions and types of vehicles, and their accompanying requirements for a multitude of highly complex test instrumentations, have generated a need for a reliable and accurate specimen evaluator.

Testing space vehicle electronic equipment under simulated environmental conditions is a complicated and time-consuming procedure. This is truer than ever today, when tests are still being performed manually and the results recorded by hand. This imposes an intolerable demand for more time and consequently delays the test program.

Each vehicle tested under current procedures requires the use of specialized test apparatus in conjunction with the test chamber and its associated equipment. This means that several technicians are needed to perform the test and to calibrate the equipment, which dictates an increase in setup and test time.

Also, the use of specialized test equipment tends to produce many test equipment malfunctions, which further delay environmental testing of complex electronic specimens.

**GSE** SPACE

## 'APATS' To Speed Environment Testing

by **David B. Dobson**

*Defense Electronics Product Div.  
Radio Corporation of America*

• **APATS joins HIVOS**—To provide the capability of testing and evaluating spacecraft specimens automatically, RCA designed and built the automatic programmer and test system (APATS) for use with the Lockheed high-vacuum orbital simulator (HIVOS). This simulator is now being erected.

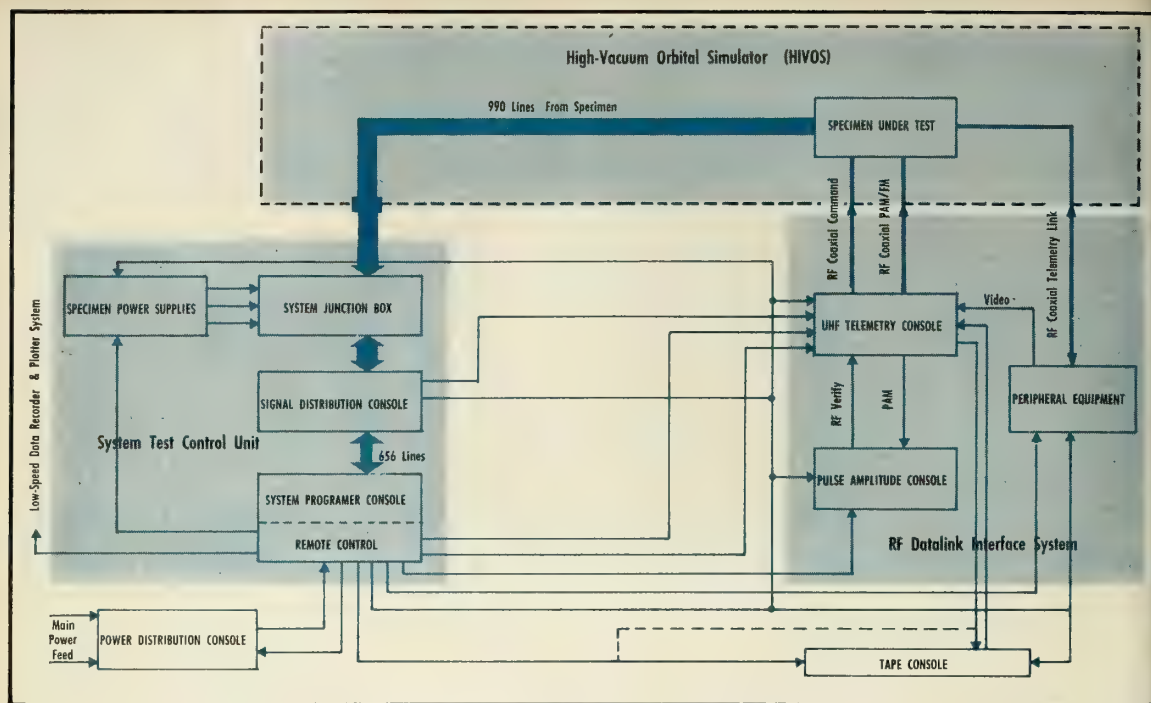
Mounted in 12 racks and using standardized functional modules, APATS provides an easily maintained and expanded instrumentation system, its developers believe. Although requirements for the marriage of HIVOS and APATS were extremely complex, the test system was completed and ready for installation within 9 months.

APATS design eliminates the need for special-purpose test equipments, since it is an integrated, general-purpose, automatic system capable of performing a multitude of tests for all specimens to be evaluated in the simulator. Because test equipment calibration, maintenance, and operation are automated, the number of operating personnel can be kept to a minimum.

The system employs RCA solid-state circuit designs previously proven extremely reliable and efficient in Army Signal Corps systems. Circuits which make up the digital control logic elements—such as gates, registers, counters, power amplifiers, relay drivers, comparators, program controllers and tape controls—all have proven records of operational reliability.

• **System description** — APATS automatically performs preprogrammed tests on vehicle and satellite specimens while they are contained in the simula-





tor. Tests essentially consist of (1) generating stimulus, (2) programing the exact destination to which the stimulus will be sent, and (3) evaluating the specimen response to each stimulus.

Results of the tests are decoded, stored, displayed, and/or printed out on hard copy.

In the case of the r-f data-link interface subsystem, stimuli will be in the form of an r-f interrogation of the specimen under test. Specimen return to APATS is stored on video tape and simultaneously translated by pulse-amplitude-modulated telemetry apparatus into analog messages representing the data being transmitted.

APATS consists of five major subsystems; a system test control unit, an r-f data-link interface system, a tape recorder console, a power distribution console, and a mobile unit containing the peripheral equipment. An overall block diagram of APATS is shown in the accompanying illustration.

The system test control unit is comprised of a main junction box, specimen power supplies, signal distribution console, and a system programmer. The system junction box receives voltage-monitoring and sensor lines from the specimen. These lines are routed to the signal distribution console.

Outputs from the lines are available at a patch panel on the distribution console where they can be monitored, recorded and, as necessary, controlled. Monitoring, recording, and evaluation

of specimen-activation events and specimen malfunctions are performed by this console.

The programmer console performs the function of a central programmer-comparator. In addition to remote control of the other APATS consoles, the console automatically performs all of the comparison and evaluation measurements of the specimen function. The programmer can control the selections of stimuli, select test points to be monitored, and determine program continuation in accordance with the measurement and evaluation results.

The r-f data-link interface system consists of a uhf telemetry console and a pulse-amplitude-modulation (PAM) console. The uhf telemetry console transmits self-contained, preprogrammed command messages to the specimen by means of coaxial cables. It is also capable of performing wide-band and narrow-band evaluation of power, frequency, and frequency deviation of the PAM telemetry wave train received from the specimen.

The PAM video is recovered and sent to the tape reader console for storage, and to a discriminator for demodulation. The resulting pulse amplitude signal is fed to the telemetering console, where it is processed for main frame and subframe separation.

Eleven of the possible 2048 channels are monitored continuously. All of them are processed sequentially and

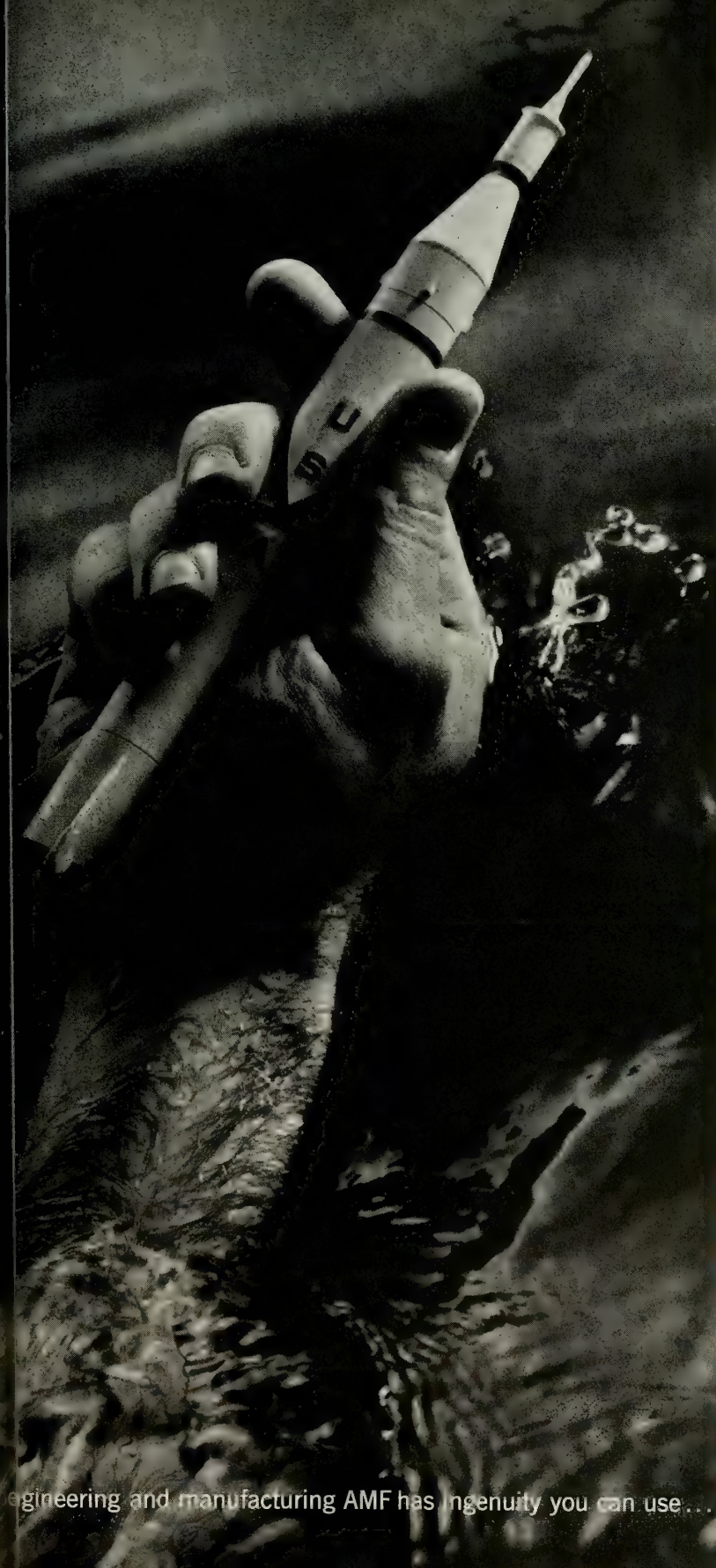
fed to the proper tape punch and to a digital printer for display.

Peripheral equipment contains a uhf telemetry receiver and provisions for six discriminators. Output of the receiver can be fed into the uhf telemetry console discriminator for PAM processing.

• **System test control**—The programmer (see simplified block diagram) automatically interprets programmed test routines from the tape reader, and then carries out the orders as directed. In performing test routines, the programmer: (1) provides stimuli and peripheral equipment control to the other consoles of the APATS system; (2) selects the desired measurement test point, function and range; (3) performs evaluations to determine if the measured parameter is within acceptable limits; and (4) makes decisions—such as which test routine to perform next or when to stop testing—based on the results of each test.

The unit is operated as a bit-serial, character-serial device, which minimizes the circuitry required and increases overall reliability. The bit-serial operation of the programmer does not increase the overall testing time of the system, since each character from the tape reader is processed in a fraction of the time that it takes for the tape reader to move from one character to the next.

This is because the tape reader per-  
(Continued on page 33)



## He's solving a real estate problem

This AMF engineer's job is determining how best to move big missiles off shore for launching. Should they be floated out horizontally, flooded to an upright position, and then launched? Or, would it be more feasible to barge them out? Might they be moved to or assembled on "Texas Towers," or would a causeway or simply land-fill be the answer?

Behind the project is our shrinking real estate at launching sites, plus the hazards inherent in launching Saturn-sized missiles (and the coming, nuclear-powered missiles) near other installations. Off-shore launching may be the answer.

Feasibility studies of all types are an AMF specialty. What kind of remotely controlled machinery is required to service nuclear-powered aircraft? What kind of habitation could be built on (or under) the surface of the moon? What sort of machines (manned and unmanned) could survey the moon's surface without, for example, falling into a fissure? What is the best way to assemble a space station? All these are problems AMF engineers are presently investigating.

If your problem is the first of its kind, AMF will not, of course, have met it before. But AMF's long experience in accepting totally unique challenges gives it an advantage enjoyed by few other organizations concerned with ground support, launchability and space environment. To get further information write American Machine & Foundry Company, 261 Madison Avenue, New York 16, N. Y.



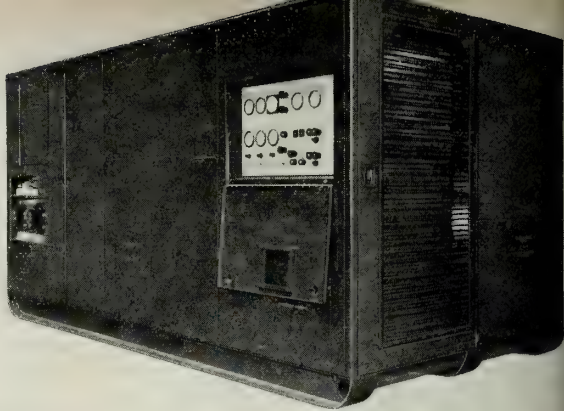
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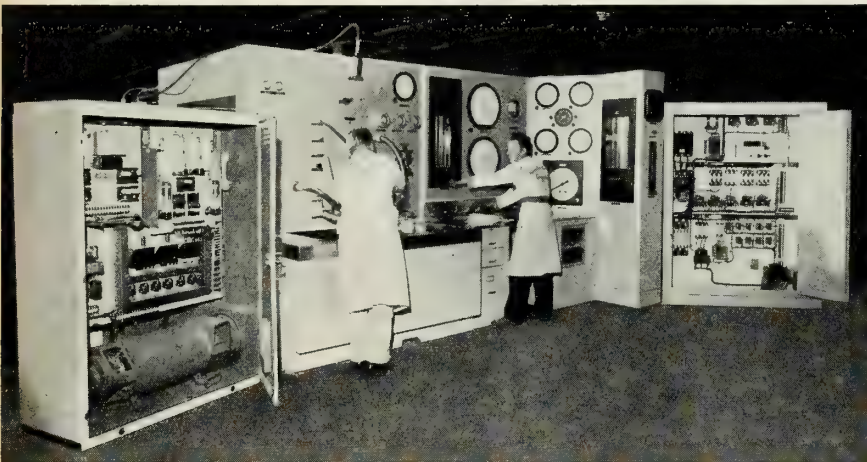




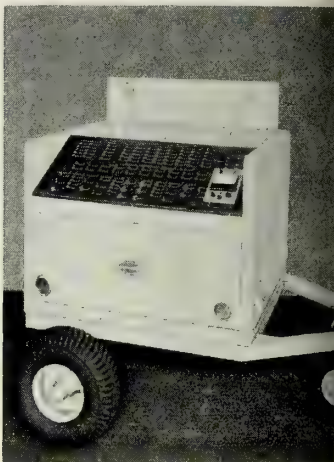
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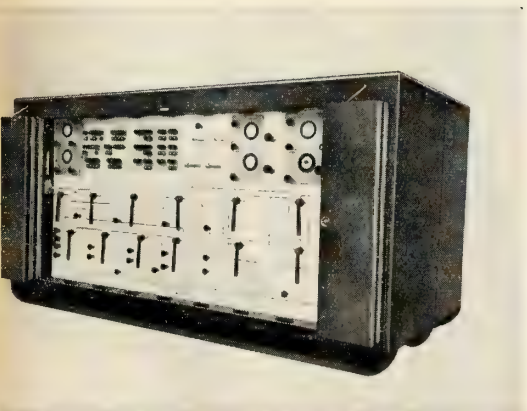


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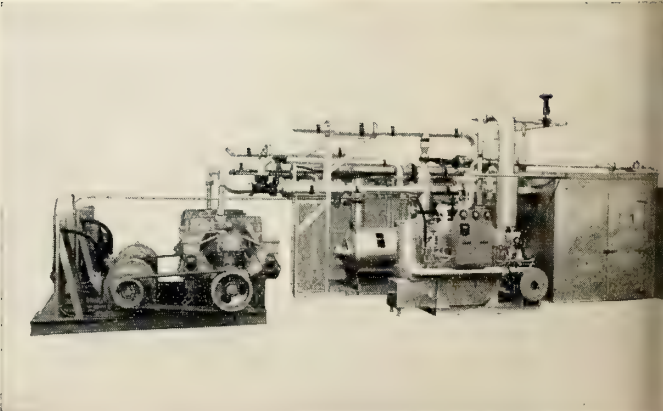


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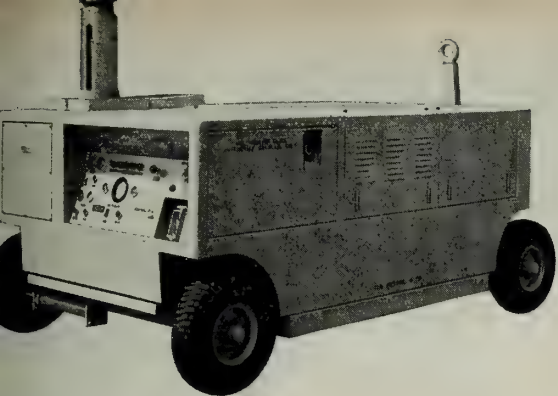
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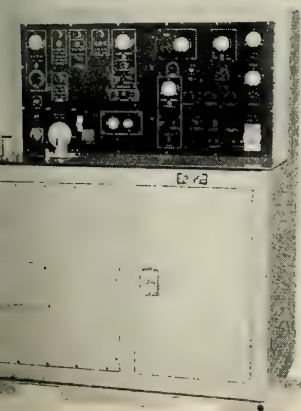
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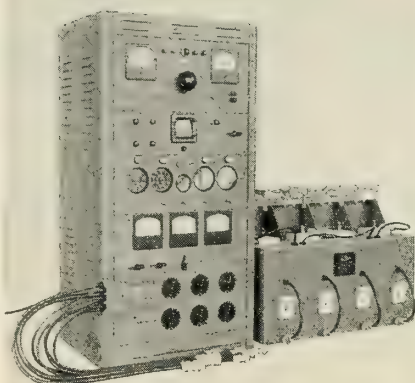
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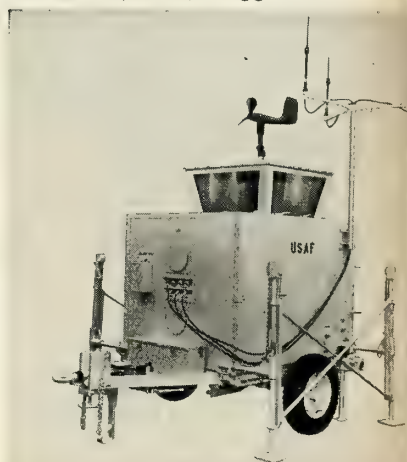
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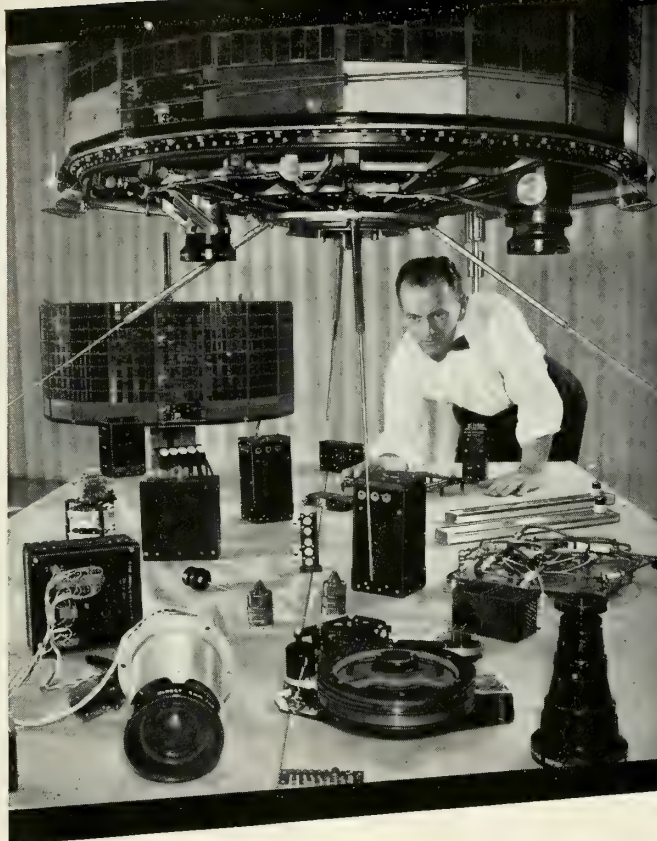
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A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

## NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

### TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

### THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to this long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

### CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation meteorological satellites.

If you are a professional physicist, engineer, or mathematician and interested in participating in such challenging projects and stimulating team efforts, contact the Employment Manager, RCA Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.



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(Continued from page 26)

forms conversions at the rate of 200 characters (frames) per second (actual character read time is approximately 1.7 milliseconds), while the time required to process the character is less than 0.16 millisecond. Thus, a factor of greater than 10 to 1 exists between programmer processing time and the tape-reader conversion rate.

In the normal mode of operation, data pertaining to a particular test sequence are searched for and, when located, read into the programmer. Tests on the tape are preceded by tape address instructions and addresses, enabling the programmer to locate desired data and to sense when to read the data into the programmer.

After completing the tape search operation, the programmer performs the test sequences stored on the tape.

Overall operation of the programmer is controlled by the instructions obtained for either the test sequences, manual commands, or remote inputs. During testing, the program control element obtains instructions from tape, interprets them, and issues appropriate commands to other units. These instructions may be: (1) commands which select particular stimuli, (2) commands which set up other console functions, (3) measurement test-point selection commands, (4) a comparison command, or (5) commands to branch to a new series of tests.

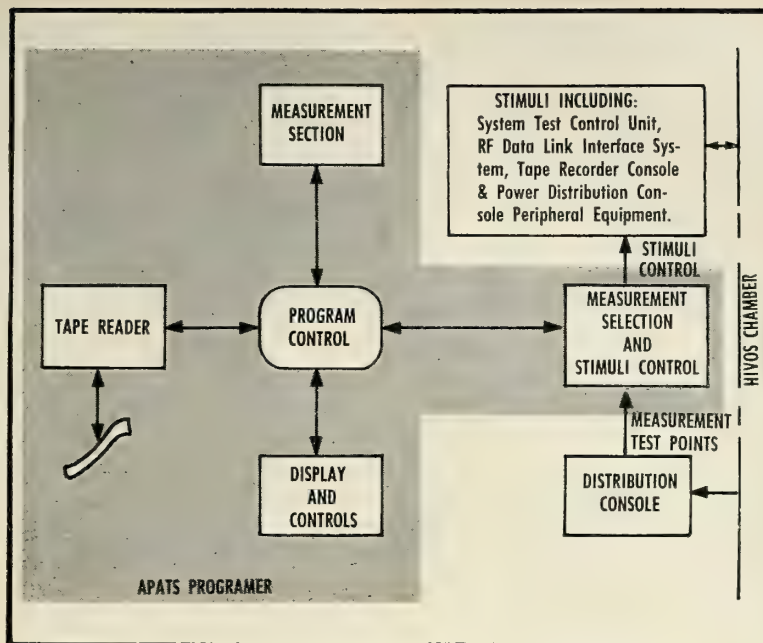
The instruments may also contain "display" or "print" commands, or they may select a particular measurement range and measurement function.

At all times the program control, along with the instructions, controls the flow of data to and from the various units of the system. Provisions for remote control of the program control unit are included in the system for interrupting programmer operation until a particular subsystem operation is complete.

A typical test sequence might require data to be routed to the stimuli control unit, which would then select the desired stimuli for the specimen under test in the HIVOS chamber. Next the measurement test-point selector would be commanded to route the proper monitoring point from the distribution console to the measurement section.

The instructions would then select the range and type of measurement, followed by a setting of the upper and lower limits of the parameter to be measured into the appropriate storage device.

After a comparison command, the programmer would be instructed to either branch to a new test sequence or con-



FUNCTIONAL DIAGRAM of APATS system programmer.

tinue on to the next test in the original sequence. This process of performing tests from tape would be continued until testing was completed or stopped, or a defective unit was detected.

The system junction box provides terminal points for 990 incoming specimen lines. In addition, it accepts d-c power from the specimen power supplies for routing to the unit under test.

Incoming specimen lines are routed to the distribution console, where any information from the specimen can be monitored, recorded, or controlled. Of the 990 lines, 656 lines are routed from the distribution consoles to other APATS consoles.

Specimen power supplies are controlled both locally and remotely from the programmer console.

The signal distribution console receives signals of the specimen function that are routed through its interface connectors. Signals from the specimen umbilical and test plugs are routed via a patch system to their respective connectors. These and other signals generated by the system programmer and system test control unit are monitored on the input test point panel with a digital voltmeter and an oscilloscope. The distribution console provides a means for monitoring the squib lines.

#### • R-f data-link interface system—

Upon command of the programmer console, a message generator converts and clocks the 39-bit parallel message information from the punched-paper tape reader to 37 bits of message. These are fed serially to a voltage-controlled os-

cillator. The remaining two bits are used to recognize one of four different types of messages. Message-type information is used to gate the 37 circuits that select which bit-time slots will be blocked for each message.

Output of the voltage-controlled oscillator (VCO) is one of three frequencies: 43 kc for a logical "1", 37 kc for a logical "9", and 40 kc for no information. The VCO output is mixed with a 1-kc sine wave, generated by a 1-kc clock in the message generator. The resultant signal is used to frequency-modulate a 1700-1850 mc signal generator. This fm command signal is transmitted to the specimen unit under test via a coaxial cable.

The signal generator output also can be routed to a spectrum analyzer and a frequency counter, where its deviation and frequency are monitored during initial adjustments of signal-generator characteristics.

Upon receipt of a valid message, the specimen generates a 10-ms message-acceptance pulse (MAP) which is sent back to the console on one of four lines. Each line corresponds to one of the four different message types.

If the MAP is present on the proper line at the time when the message generator generates a MAP interrogation pulse, a "tape reader advance" pulse is generated. If a MAP is not generated or is not on the proper line, an error signal is generated and the tape is prevented from advancing.

The telemetry console also accepts a PAM/FM/FM signal from the speci-

(Continued on page 67)



# Takeoff From Moon Relatively Simple

*In initial lunar voyage, vehicles will carry fuel for return, other support equipment will be entirely internal*

by **Robert S. Turner**  
*Electronics Division,  
The Martin Company*

IT WILL TAKE MONTHS of final preparation, thousands of personnel, and worldwide facilities to launch a manned space vehicle moonward. How can a crew of only three men complete a vehicle checkout and launch their craft from the unprepared surface of the moon?

To answer this question, a comparison may be drawn between the requirements for launching from the earth and those for launch from the moon. The difference is considerable.

• **Mission compared**—The five-stage, earth-launched vehicle will be much larger and more complex than the moon-launched craft. The three-stage booster will lift the spacecraft into an earth orbit; then the third stage will shut down until it is restarted at the precise time for translunar injection. The lunar stages then proceed to a lunar orbit, and eventually a landing.

When the vehicle takes off from the lunar surface, the landing stage will be left on the moon—its last service being as a takeoff platform for the return flight. Thus the vehicle for the return trip to earth will be a relatively simple, one-stage affair. And this reduction in the number of stages directly reduces the complexity of the prelaunch checkout.

• **Detailed checkout on earth**—Before the spacecraft even leaves the earth, prelaunch preparations and final-launch countdown procedures must prove the readiness of the total vehicle to accomplish the entire mission. This is the last chance to look at the individual components of the many systems, to check for leaks, clearances and faulty workmanship and to verify an operation visually as well as by instruments. Specialists on each system must coordinate their activities through a test conductor—who, in turn, is coordinating these activities with those of the support functions (tracking, telemetry, range safety, rescue, computing centers and worldwide communications networks).

The prelaunch tests to establish the readiness of the vehicle to function reliably for the full duration of the mission must be performed thoroughly—and yet rapidly enough to prevent excessive running time on equipment and waste of highly volatile, venting fuels. All of this must be done with no degradation of the tested systems due to error caused by human carelessness, fatigue, ignorance or irresponsibility.

• **Electronic checkout requirement**—Hence the requirement exists for reliable electronic programing, evaluating and computing checkout equipment. Such equipment tests and evaluates component and system operation, locates malfunctions, evaluates performance and records results which are used

in external computer programs to calculate and predict the mean time between failures to insure a successful mission. Installation and checkout of these checkout devices is costly and time-consuming, but necessary to ensure the success of this highly complicated mission.

Is all this preparation an adequate basis for assuming that the success of the whole mission—return as well as the outgoing trip—will in fact be ensured? The answer must be a qualified yes—qualified by the consideration that success cannot be predicted with absolute certainty for any such pioneering venture. But the answer, even though qualified, remains yes; for the real enormous extent and thoroughness of the prelaunch checkout calculation puts the probability of success very high indeed.

• **System reliability analyzed**—The mean time between failures for these systems is a known, previously determined value. Test results for the moon landing systems can therefore be fed into the external computers along with the results of every previous test conducted on the critical system; using performance variations, mean time between failure typical performance characteristics of all previous systems, a expectation of no failure during the entire scheduled flight time can be established with almost complete certainty.

Prelaunch GSE establishes not only the absence of any malfunction in the system, but also the existence of no trends toward improper conditions. On-board checkout devices would consist of the telemetering transducers (which read out critical functions) with limited inputs to system functions, test problems programmed to check the computer and such normal gauges as Fuel Level, Tank Pressure, Oxygen Level and Power-Supply Voltage. Two complete systems will be provided on board so that the crew is assured of having at least one operable system under the worst conditions predicted.

In addition to the foregoing type of equipment, the on-board test gear would include a high-capacity, general-purpose computer. The whole complement of on-board test equipment is restricted to making system functional tests. All systems must be checked before proceeding to the next portion of the flight—earth parking orbit, translunar flight, lunar orbit injection, or lunar landing. The crew is able to abort the flight at any point before lunar landing. Thus it may be assumed that the vehicle will be in sound order when it reaches the moon.

Limited on-board maintenance must be possible. The presence of man supplies redundancy through his ability

make decisions and accomplish minor repairs. This aspect requires much more study to determine what will be done. Weight for spares will be at a premium.

• **Safety considerations**—Another factor leading to a large expenditure of man-hours and facilities for earth launch is safety. This includes safety for those conducting the tests, the astronauts, the bystanders and those people that lie along the flight path of the vehicle. The highly flammable and explosive fluids and solids in the various systems require the use of many remote control devices, additional transportation, guards, etc. Abort, recovery, and retrieval of the spacecraft and astronauts during all operations where earth landing is the final result involves an extremely large force of people, airplanes, ships, helicopters, tracking locating and communications networks able to cover most of the earth's surface.

In contrast, the astronaut team must launch from the moon with no external support. Although there is no safety problem due to external influences, a failure during the launch maneuver from the moon will almost certainly be fatal.

• **Lunar launch checkout**—Assuming that the landing on the moon was accomplished within design limits, a high degree of reliability and confidence will have been established in the spacecraft operating systems, particularly the guidance and control systems. The only real unknown at this point is the lunar takeoff engine. The same type of procedures and systems for checking the lunar landing engine were employed during the flight with the same on-board checking equipment used to checkout the lunar takeoff engine.

The checkout of the lunar takeoff engine will be routine. The guidance and control systems will continue to be employed as they were enroute. The on-board equipment will check these systems. The astronauts' knowledge of their position on the moon will provide an exact reference for any resetting of position or alignment of the stable platform.

The launching of a vehicle to the moon is a very complicated mathematical problem from the standpoint of establishing the trajectory to be flown and the task of determining if the vehicle is on the right trajectory and, if not, just what the correction to return to course will be.

The earth launching is also complicated by the fact that the launching point is continually moving relative to the earth-moon line because of the rotation of the earth about its axis. This fact requires a constant changing of the trajectory to be flown, and therefore a continuous input to the guidance system

to provide it with the correct information at launch time. Since the launch azimuth is limited by range safety factors and the desire to miss the Van Allen radiation belts, the allowable time to launch is restricted to a few hours a day.

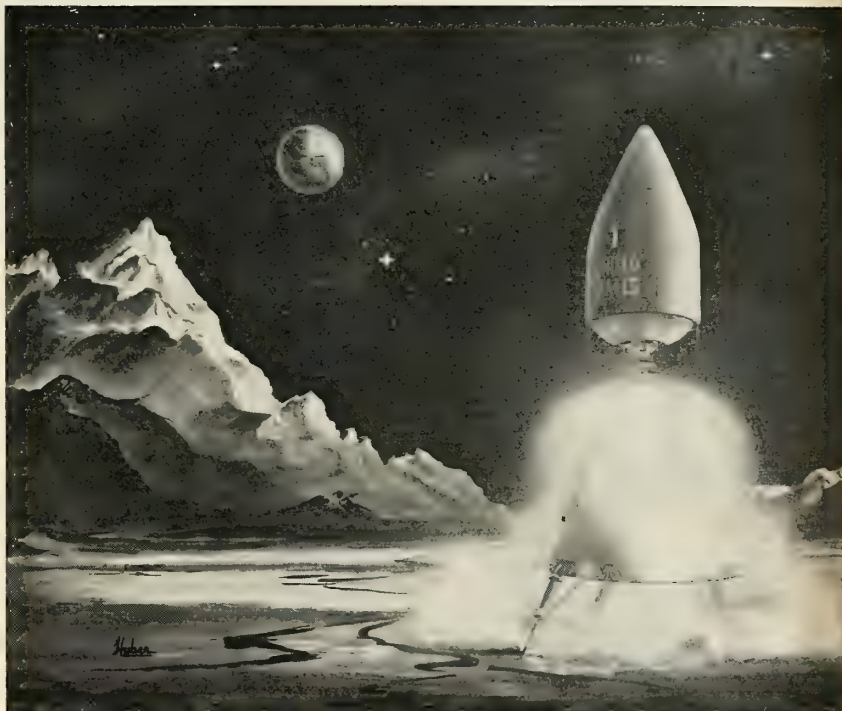
• **Lunar launch simpler**—Although the accuracy requirement for guidance from the earth to the moon and the moon to the earth is approximately the same, the launch from the moon is not as complicated because the moon does not rotate relative to the earth-moon line.

This difference is very important because it eliminates the requirement for continuously changing inputs to the

computing device will be eliminated.

It is interesting to note that the vehicle can launch from the moon on a present azimuth at any time and return to the earth's atmosphere, although the crew will not have a selection of landing site under such a condition. However, this is of prime importance in the case of an emergency situation—such as a dangerously low supply of oxygen—in which case immediate return is necessary.

• **Further considerations**—The present state of the art of orbital mechanics and of guidance, control and propulsion systems, and our lack of knowledge of the moon's surface make it seem impractical to assume that a lunar



*ARTIST'S CONCEPT of early blastoff from moon shows how only lunar support equipment will be landing stage, serving as takeoff platform for return trip.*

guidance system to obtain the required trajectory to earth. The proper launch azimuth can be preset for the particular moon launching point. At this point time becomes the only variable, in order to launch on the trajectory that will return the vehicle to earth along a particular trajectory approaching a present landing area from a particular direction. A variation in the launch time will change the direction of approach to the landing area and will require a change in the point at which trans-earth injection is accomplished.

This fact allows the astronaut crew to use information precalculated and available to them in tabular form. Therefore, the ground support of a

landing spacecraft could expect to be refueled on the surface of the moon.

First of all, we do not now have the capability to spotland a load (or, more likely, several loads) that the first astronauts could hope to find or assemble for use in the time allowed for the initial stay on the moon surface. Also, emergency situations for immediate return must be met with the capability of launching very soon after landing. Therefore, the initial lunar landing craft must carry its return fuel and all the support equipment.

The lunar landing and takeoff must be similar to an aircraft intermediate landing and takeoff. There must be  
(Continued on page 68)



# Mariner Support Will be Tailored

**JPL has set up 12-phase program for developing spacecraft and support equipment in close coordination**

SUPPORT EQUIPMENT for the *Mariner* Venus probes will be closely linked with the laboratory test equipment used in developing and testing hardware.

A high percentage of *Mariner* GSE will be supplied as individual test and checkout components by contractors furnishing a specific subsystem or scientific experiment for *Mariner*. In this way, support equipment will be tailored to the exact needs of the spacecraft and its payload.

Following the successful test and acceptance by Jet Propulsion Laboratory of each subsystem or scientific instrument package for *Mariner*, the contractor-supplied support equipment will be "packaged" for ease of use.

Instrumentation-checkout GSE will be integrated into a single, multi-function unit to enable rapid test of *Mariner* payload subsystems and instrumentation.

The narrow time envelope available for *Mariner* launches—the period during which the necessary reference planetary bodies are properly aligned—demands fast, integrated checkout of the instrumentation. All power supplies to the instrumentation, for example, must be validated simultaneously. Time is too precious for leisurely examination of each circuit once the ideal launch envelope is reached. Detailed checks

will be accomplished in early phases, and repeated many times before launch.

GSE for the spacecraft itself will not require the high degree of integration necessary in the instrumentation packages. It will probably be semi-integrated for compactness, since the relatively low usage rate makes it uneconomical to spend many engineering hours on special packaging. Standard size, rack-mounted modules are believed sufficient. However, time will be spent on developing accuracy and reliability in support equipment.

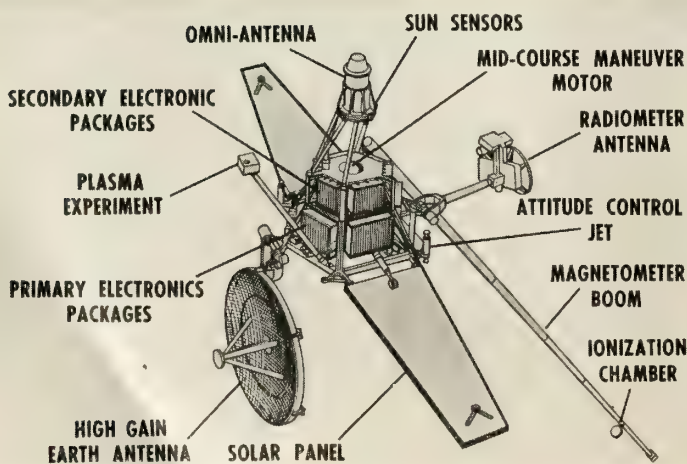
• **Hand-in-hand approach**—It is believed that few new techniques will be involved in the checkout of the *Centaur* or *Agena B* vehicles, other than those required to satisfy the program's built-in need for accuracy with speed. However, the JPL program for *Mariner* GSE does differ in many respects from less demanding space vehicles.

*Mariner* GSE and development, test equipment are virtually one and the same thing. JPL's newly completed space simulation chamber performs a ground support function for *Mariner* and other interplanetary programs. Other special items include a device for testing minimum-force actuation of *Mariner's* extension arms and booms and a mockup of the *Centaur* for compatibility tests.

JPL has laid out a 12-phase test and development program for *Mariner* in which the spacecraft and its GSE will be developed hand-in-hand. With this approach, the primary difference between the development program and pre-launch checkout becomes just matter of time. The steps will be almost identical, as will much of the launch site GSE.

• **First push**—The program, designated the Formal Systems Test Phase, is closely timed. The first big push comes in Phase 1—assembly of equipment and hardware—in JPL's assembly building. During this period, considered a test phase because problems of mechanical nature will be solved, the first use of a piece of directly-related *Mariner* GSE—such as the primary test fixture—is brought into play.

Phase 2—scheduled for 7-10 days—is the Systems Test Complex Checkout: verification of test complex workability. GSE units will be checked on



DETAILED DRAWING shows *Mariner* equipment needing GSE.

# Needs of Vehicle and Capsule

and calibrated to make certain that the spacecraft subsystems and experiments will not be exposed to catastrophic damage. All electrical connections and leads will be checked for specific voltages at the correct pins. This phase is critical, since *Mariner* will have few standby components or spare assemblies to replace items damaged in testing "accidents."

When Phase 3—initial "turn-on" of the spacecraft—is reached, extreme caution will be exercised so that power will be applied gradually, in planned steps. The spacecraft's ring harness will first be engaged with no subsystems connected.

All crucial input voltages will be verified with meters at harness leads to prevent damage. Dummy loads will be connected to the ring harness after the basic power supply has been plugged in and the inverter checked out satisfactorily. Special attention will be paid to any serious degradation of the power and voltage loss during this portion of the test.

- **Plugging in**—Next, actual "black boxes" are plugged in, one at a time. Each is then energized for a continuous period of several hours to observe basic operation. This portion of Phase 3 can be compared to laboratory bench tests with these exceptions:

- Assemblies are physically mounted on the spacecraft, providing a degree of systems integration.

- The *Mariner* power supply is used for the subsystems and experiments.

- Power is fed through the actual ring harness.

During the latter part of Phase 3, each *Mariner* subsystem undergoes a more careful checkout. Various inputs and outputs are routed through the spacecraft circuits, rather than synthesized on a bench. Loads and signals are then applied to the final subsystems, which comprise some 75-80% of the entire spacecraft system. Follow-up circuitry, such as amplifiers and analog-digital converters for some of the scientific instruments, is placed into the system during this phase.

- **Key subsystem**—Checkout of the ring harness is an extremely sensitive area. In several past satellites this assembly has been increasingly trouble-

some as spacecraft designs became more complex. Therefore, much thought and effort is going into the *Mariner* harness—considered by many the most important subsystem in the spacecraft. It will receive special attention in eight of the 12 test phases and will consume a large total of the scheduled test hours.

Since a careful balance has to be achieved between shielding for the circuits and weight and size limitation, the ring harness for the spacecraft subsystems and scientific experiments must be tailored to the specific installations. This means a sizeable total weight. Each circuit must be analyzed to provide a "Signal Characteristics Data Sheet" specifying voltage, current, wave shape, rise time, and other parameters for that particular circuit.

Squib circuits—controlling nearly all mechanical releases, extensions and actuators—cause many of the circuit problems. Due to the short, heavy surges of current triggered through the squibs, the *Mariner* squib harness will have to be routed independently from the main harness to reduce the effect of its inductive fields on other circuits.

Phase 6—initiating the Formal Systems Test during which the flight sequence will generally be followed—is designed to compress the time required for a particular action to a practical value. The Central Computer and Sequence (CCS) in particular is one of the items that can be speeded up for the programed 180 days transit time to reach Venus. The CCS is designed to be "jumped" to a future time or shifted into an operational speed 15 to 25 times faster than normal. Three weeks is allowed for Phase 6, but it is hoped that one week will be sufficient.

- **New gimmick**—In addition to the umbilical cable link from all leads to the GSE and the telemetry link, a new system will be introduced on *Mariner*—direct access to "cases" installed in the spacecraft with internal leads to important circuit points. These pick-offs will give the testing personnel—both JPL and contractors—the ability to run test leads back to that part of the GSE which corresponds to a particular subsystem.

These parallel test leads will provide sufficient isolation to minimize the effect of the GSE. Specifically, the test-

ing area can monitor the subsystems without disturbing them, thereby leaving interfaces undisturbed. The access leads will be left on until Phase 9 is started.

Phase 7—weight, CG, and Moment of Inertia measurements—enables JPL technicians to calculate these parameters very precisely to insure that they fall within specified limits. Also, during this phase the exact size of the exhaust throats in the gas jets of the attitude control system will be determined.

- **Chamber debut**—Phase 8 will mark the first use of JPL's new space simulation chamber, when the *Mariner* and its GSE is moved into the new facility for Environmental Tests.

A major objective of these tests will be complete thermal isolation of the spacecraft in order to simulate the environment of deep space. The special pedestal on which *Mariner* will be mounted is to be cooled by liquid nitrogen matching the supercold of the surrounding chamber walls. There will also be a thermal barrier between the spacecraft and the pedestal, to insure uniform temperature on all surfaces of the spacecraft.

Even the direct access leads from the GSE to the subsystems and experiments will be conditioned to the space environment by the use of a special conduit cooled by liquid nitrogen on its exterior surface. However, the interior of the cable carrying the wires will be maintained at the same temperature as the spacecraft interior by the use of heaters in the cable.

Extreme care must be exercised in placing these cables to eliminate the shielding effect they might introduce in relation to the cold walls or the heat of the simulated solar radiation entering at the top of the chamber. The spacecraft will be operated as if it were in flight, with some events compressed in time.

- **Trial by shaking**—Following the space environment tests, the spacecraft will be returned to the assembly building and subjected to vibration tests. It will be run through a streamlined systems test—again compressing in time many of the events—while undergoing both low-frequency and high-frequency vibration tests. The JPL hydraulic

(Continued on page 67)



# Prospector May Haul First Moon GSE

**NASA considers possibility of making program's major goal the support of manned lunar expeditions; a look at 'LSE'**

NASA'S *PROSPECTOR* may take the first "ground" support equipment to the moon, where it might even provide men with a means of transportation.

Although it was conceived originally as an unmanned lunar exploration program, space officials now feel that *Prospector* may be replaced in this role by its predecessors, *Ranger* and *Surveyor* (M/R, Aug. 14, p. 37).

NASA is giving increased thought to another part of the *Prospector* concept: its use as a means of support for the U.S. astronauts who are due to be landing on the moon at about the same time (1966-67) that the first *Prospectors* are scheduled to be launched.

This envisions landing supplies for a manned expedition aboard the *Prospector* carrier vehicle. It could also include using the originally planned unmanned lunar surface vehicle as "wheels" for the human explorers.

Pending the government's decision on exactly what *Prospector's* mission will be, industry firms involved in it describe their studies as "*Prospector-type*." Company spokesmen are also a bit reluctant to discuss their plans in great detail because of proprietary thinking toward the program's payoff.

Nevertheless, planning has proceeded rapidly and proposals are well advanced.

The planners all agree that very little new support equipment will be needed for the lunar exploration phase of *Prospector*—if that phase is carried out—but that the earth-based equipment will have to be highly reliable.

• **Stations on overtime**—As the lunar-based vehicle moves over the surface, the moon will be visible to earth tracking stations for approximately the

time it takes the sun to move from horizon to horizon. This means that transfer of control from station will not be as frequent as with lower satellite orbits. But it will require that each station remain operative for periods of 8-12 hrs., rather than the "on" for 15-20 min., then "off" for 90 min. or more.

Companies with *Prospector-type* studies are quick to point out that there are no fundamental limitations for earth-based receiving stations. The present National Aeronautics and Space Administration/Jet Propulsion Laboratory Deep Space Instrumentation Facility (DSIF) will do the job. But there are other factors.

If the DSIF stays with its present 85-ft. antenna system, it will boost power requirements for the *Prospector's* lunar exploration vehicle. If the full 250-ft. antenna system is completed in time, the moon vehicle's TV power requirements may be cut by about 10%. A *Prospector* operation would not be "limited" by use of the 85-ft. antenna, but the vehicle power requirements could be considerably altered.

There may be a loading problem at earth facilities if the *Prospector* vehicle has a very limited life before fuel pellets evaporate, batteries run down, or drive motors wear out. It will be necessary to obtain all data possible, as well as control the lunar-based vehicle's surface explorations, during this lifetime. It cannot be allowed to "just sit and deteriorate."

This presents the possible problem of tying up the earth-based communications net—eliminating it for any other work. But, industry studies indicate this can be solved by adding extra receiving equipment and data recorders, including

a large amount of video tape system for TV data.

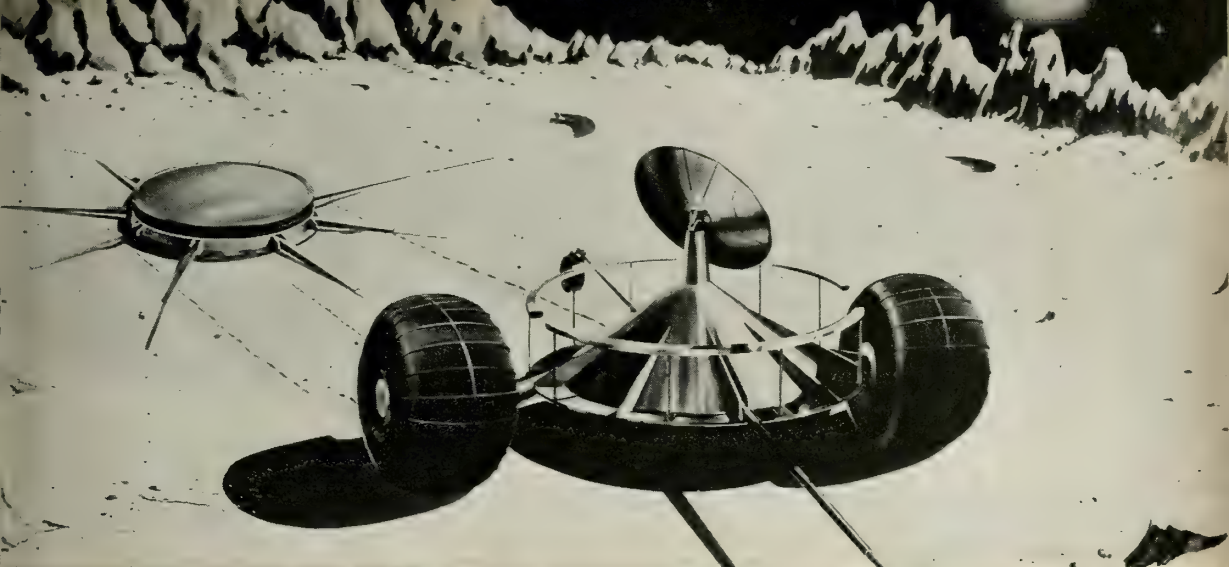
The DSIF has, in its present form, sufficient band width to handle *Prospector* data and control functions for TV scan, vehicle velocity, and other operations. Bit studies also note that this factor is a wide variable. It would be simple to design a roving vehicle (lunar) that could transmit more information than could be handled via a "reasonable" earth station. But, for what industry studies indicate as a "logical" mobile lunar vehicle, the DSIF net is satisfactory.

Other than an increase in the amount of data equipment installed tracking and control stations, little new will be needed. But a very large amount of data will be received. If everything the huge amount of video tape data recording system will be required for the huge amount of video tape data received as the vehicle rumbles about the lunar surface.

• **Seats for kibitzers**—DSIF stations will likely require a rather complex control console and data display system to enable operators to make intelligent decisions while the vehicle moves about the moon. As one scientist puts it: "The time you add enough grandstar seats behind the operator for all the kibitzers telling him to 'watch out and don't knock into that rock over there you're going to have quite an auditorium.'"

A large installation will be needed in DSIF stations for data links, data processing, data recording, and "quick look" processing for some readout the form of what the operator has to do to drive the vehicle.

The monitoring system will not



ARTIST'S CONCEPT shows Prospector-type vehicle as it travels over the lunar surface.

like the multi-function, short-flight, Mercury system. The time element, although critical, is not extremely sensitive.

• **Easy inspection**—One advantage of a Prospector-type lunar vehicle is that it may be stopped at any time a decision is required. The vehicle may be "parked" while a difficulty is diagnosed.

"It won't go away," an engineer told M/R, adding that this is a "big factor in accomplishing the vehicle's mission."

"If you have, for example, a squeaky right rear wheel, you can run the vehicle back and forth to decide what you should do about it. The only risk you take is the possibility of some propellant boil-off, but you don't have to rush about such things—and this is a big, important factor."

• **GSE vs LSE**—Scientists and engineers draw a fine line between GSE and lunar support equipment (LSE) for Prospector and other, future, manned or unmanned programs. The trend is towards terming such equipment LSE, despite the more commonly accepted GSE tag. In general, all equipment with the exception of "the rocket to get him here and the one to get him back" is support equipment.

It is fairly obvious that manned lunar operation will require about as much equipment as operations on earth. But the equally obvious differences are receiving much study.

Firms queried by M/R are in complete agreement that there is sufficient knowledge of the lunar environment to help in working out problems. There is equal agreement that there are probably some "specific little things" that are not

known. These, however, are felt to be relatively unimportant at the moment.

LSE cannot take what might be considered the "crude" form of GSE for earth-based satellite or ballistic missile operations. The cost-per-pound of putting such equipment on the moon is prohibitive.

The per-lb. cost will probably have the greatest effect of all factors on GSE/LSE—no matter if it is canned soup or rocket propellant. The dollars-per-lb. to put it on the moon are the same.

A little-studied area, according to some firms, is the need for machine tools at a manned lunar base. There is little chance that it would be possible to tote a cast-iron lathe to the moon. The payload penalty would be too great. In addition, the lunar environment will result in equipment with an appearance very different from that of support equipment as it is known today. LSE will have to be designed to the structural weight criteria as present missiles and spacecraft.

• **Premium on imagination**—The problem here is how to design equipment without previous experience—LSE has not been done before. The solution, firms queried by M/R said, is to divorce present thinking and LSE design. The basic approach is: "Here I am on the moon—it has cost me 'X' dollars per lb. to get my stuff here and what do I have?"

There is little thought of using exotic materials in LSE. Conventional materials will probably do the job. The only limitation will be the degree of engineering imaginativeness.

"If a new material comes along, we

may use it," is the basic philosophy. But the problem is far removed from metallurgical development necessary for boost-glide vehicles, for example. The moon has a "nasty, but not extreme environment."

An early approach to GSE/LSE was to rely on multiple vehicles and cannibalizing, but industry studies now rely heavily upon such planned vehicles as Saturn and Nova, which will put down enough tonnage in one mission to support a multi-man lunar station.

The big boosters will have an advantage at the lunar end, also. It is expected that the terminal vehicle will not burn out completely. This may mean something like 2000 lbs. of propellant remaining at lunar landing. It may also mean that a big booster will be able to drop an unmanned lunar exploration vehicle on the moon surface, complete with its own fuel—but that there may be enough fuel remaining in the landing vehicle to supply additional vehicle fuel, hydrogen and oxygen for a water source, breathing oxygen, and coolant for electronic gear.

With the "proper" propulsion system in a lunar exploration vehicle, even 500-1000 lbs. of propellant remaining after a lunar landing could run a lunar surface exploration vehicle for 500-1000 mi., according to some estimates.

Until the Prospector program is given a fully delineated mission, GSE/LSE studies must be a bit vague. Some firms believe they have all the answers no matter what path is selected—others are not so sure. Few are talking in specifics, but all agree that GSE/LSE will be developed in scheduled, small steps. There are no precedents. #



## Skybolt on Its Own Once Aboard B-52

*Air-launched missile's support will tie in closely with those of aircraft; test gear integrated*

by Frank G. McGuire

TEST AND CHECKOUT procedures are being molded for *Skybolt* to support a "hands-off" policy once the ALBM is on its aircraft.

*Skybolt*—being developed by Douglas Aircraft Company for the Air Force Aeronautical Systems Division—will be tested mainly on the ground, with only an automatic assurance check in the air as part of the launch sequence.

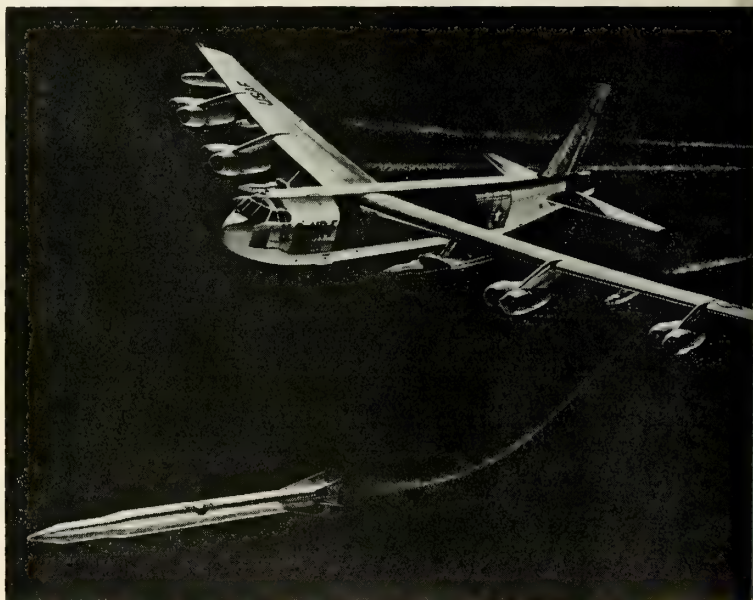
In view of the rapid reaction time and minimum maintenance turn-around time allowable on SAC's weapons, the ground tests on both missile and aircraft equipment have been automated. Once loaded aboard the B-52, the air-launched ballistic missile will stay on its pylon until definite indication of a malfunction or the arrival of a scheduled periodic maintenance date. Ground assurance checks are possible only on installed missiles and aircraft utilizing ground power and cooling carts.

*Skybolt* will be used by SAC Strategic Wings. Ground support requirements will be handled by integration into existing facilities, thus eliminating any large financial outlay for special buildings or other structures and facilities.

One of the most rigid requirements for *Skybolt's* deployment is that the missile must not degrade the performance, alert time, turn-around time or other factors of the B-52 vital to SAC effectiveness.

S. L. Gehring, Douglas' project engineer for the *Skybolt* support system, said this goal will be met by integration of the support functions into those of the aircraft maintenance cycle and by the use of automatic fault isolation equipment.

Douglas has conducted a detailed reliability analysis of anticipated black box failures. Support equipment and



*INERT SKYBOLTS*—as shown in this artist's conception—were dropped from B-52's in series of tests just completed at Eglin AFB, Fla. Target was 15-mile long bombing range.

spare parts are to be provided so that a SAC base will be able to handle most *Skybolt* repair and maintenance requirements within the required maintenance recovery time.

In those cases where repair by base Air Force personnel is not recommended, the hardware has been so designed that the smallest practical part is removed and returned to the depot.

By this method, *Skybolt* can be maintained at maximum readiness with a minimum of major equipment spares in the supply pipeline. Modular construction using standardized components has aided in this achievement.

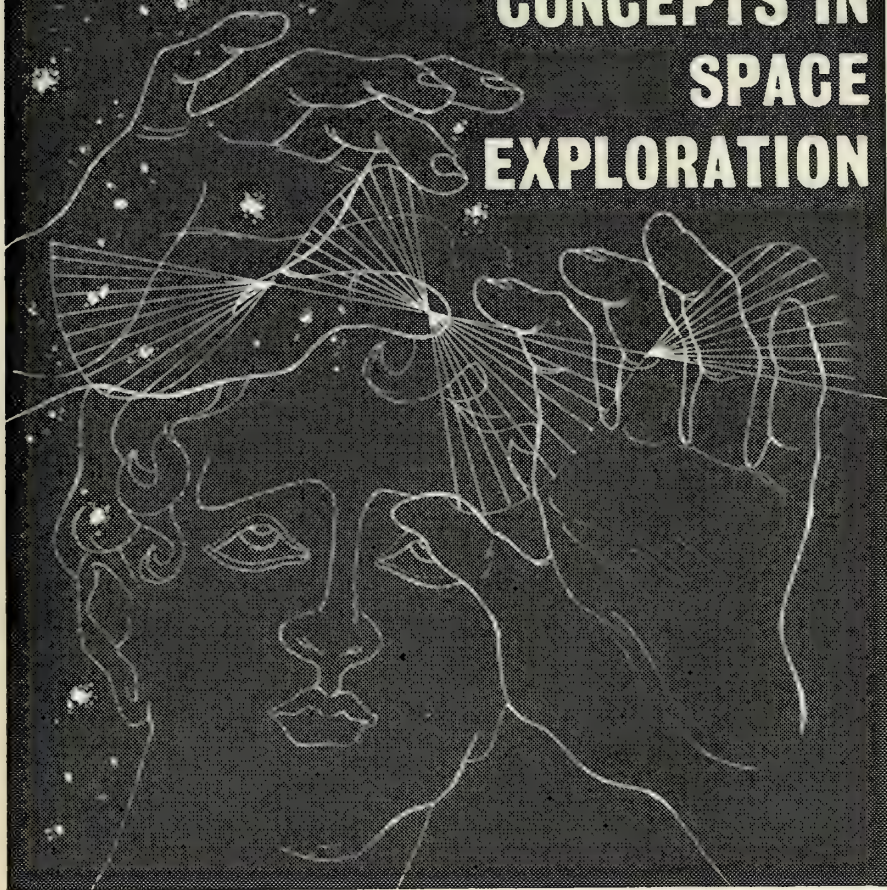
• **Subcontractor policy** — Douglas has followed the policy of having each major subcontractor build the test equipment necessary for checking out the portion of the system provided by him. Test units specified by Douglas using Douglas construction details, are integrated into the overall system.

Some of the major subcontractors associated with the *Skybolt* program are: Aerojet-General Corp., J. V. Fecker Division of American Optical Co., GE/Philadelphia, GE/Utica, IBM, Motorola, Nortronics Division of Northrop Corp., and Texas Instruments.

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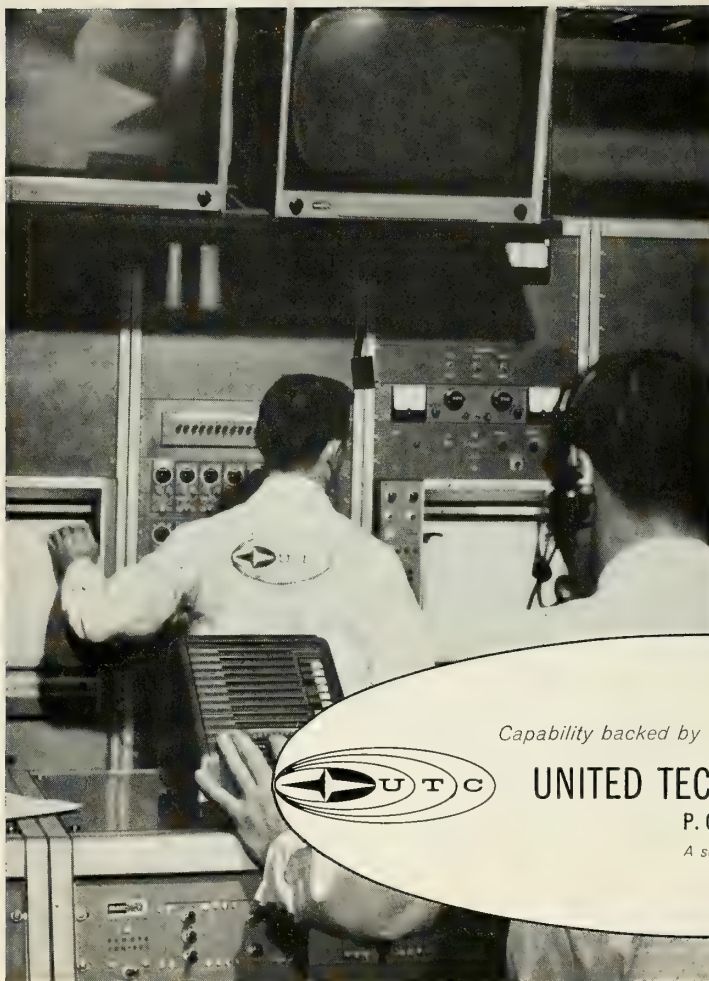
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*Left—The scene: UTC Development Center. The action: static firing test is monitored on closed-circuit TV in Remote Control and Data Acquisition Center.*

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the support equipment has been on human engineering, since operation of the equipment will be by Air Force base personnel. Existing SAC maintenance units now servicing the B-52 Strategic Wings will handle the missile system maintenance. A major design consideration is the avoidance of unnecessary complication of already demanding flight duties.

- **B-52 black boxes**—Approximately 15 black boxes containing control equipment are carried by the B-52. They range in weight from 25 to 250 pounds. The equipment is almost completely digital and automatic, and is operated by several control panels. Incorporated as a part of the control functions are monitoring circuits which, in case of malfunction, automatically indicate to the air crew sufficient fault isolation to permit evaluation of the performance capability.

An automatically sequenced missile simulator is used to check out all B-52 *Skybolt* equipment within the aircraft. In conjunction with the capabilities of the aircraft-mounted equipment to monitor its own functions, and by utilizing secondary test-point connections within that equipment, the missile simulator can evaluate performance and isolate malfunctions directly to a replaceable module.

- **Missile Checkout**—The missile itself will be thoroughly tested through a technique which utilizes, for the first time, an AN/GJQ-9 Checkout Sequence Programming Set. This equipment, the first of such to be bought in quantity by the Air Force, will serve as a core for *Skybolt* missile tests and selected module tests with suitable adapters specified by Douglas for specific *Skybolt* test operations.

The Q-9—as it is called—is expected to find almost universal use for checking ballistic missiles by providing standard tape-programed test controller and measurement standards which are common to all missile checkout procedures. Adapters are used to apply the test functions to the specific missile or subsystem under test.

- **Basic Q-9 make-up**—Built by the Bendix Corp. to meet an Air Force requirement, the Q-9 was first delivered in January, and enables semi-skilled personnel to thoroughly check out an entire missile. Major gains are effected over standard test equipment through reduced test time, reduced operator skill and reproducibility of test sequence and results. Bendix says that the Q-9 can conveniently, accurately and automatically control any desired subsystem test program or checkout sequence verification.

The basic makeup of the Q-9 consists of a tape reader, power supplies, missiles and rockets, September 18, 1961

solid-state circuitry and a tape printer, all located in 20 drawers distributed throughout five bays. The equipment is packaged in a two-bay operator's console and a three-bay measurement and selector section. Each of 18 drawers contains one or more test control functions. Two drawers are left empty to allow for expansion.

Used in conjunction with the Q-9 in a particular test is an adapter which supplies excitation and/or control to the item under test, provides stimuli for test inputs, converts output signals, where necessary, into forms acceptable to the Q-9, and provides dummy loads.

Binary-coded test-program tapes are used in the Q-9. Operation of the tapes can be conducted automatically or stepped one frame at a time for semi-automatic operation. Manual test controls have also been incorporated.

- **Test sequence control**—The test sequence from the tape unit is controlled by logic and memory circuits which perform the functions of selection of proper stimuli controls, test-point measurement channels and measurement devices; energizing of timing circuitry; inserting measurement tolerances; regulation of test continuation based on acceptability of the test; and displaying of test data on visual and/or printed readout devices.

The measurement and evaluation of a test answer involves a simultaneous comparison with prescribed high and low tolerances, with a resultant deci-

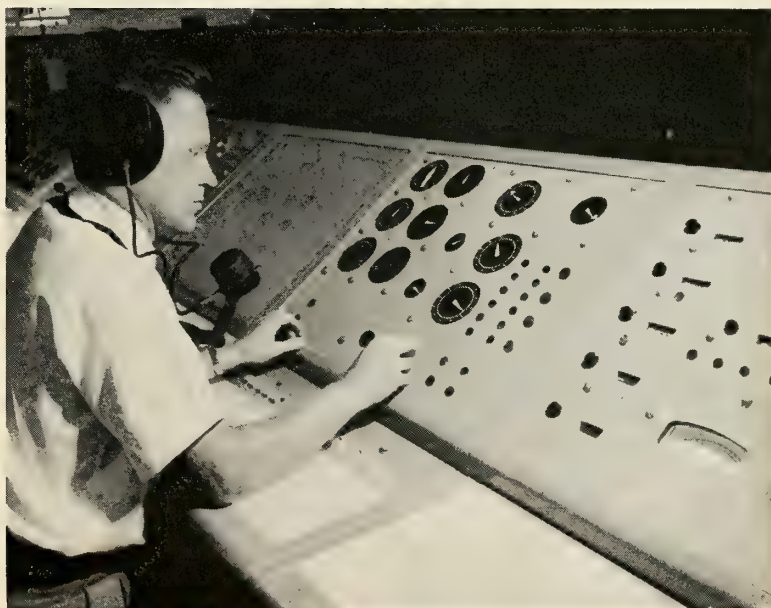
sion as a go or no-go output signal. Measurement evaluations can be made on a-c voltages, d-c voltages, frequency, time intervals, events per unit of time, resistance, voltage ratios and in-phase and quadrature voltage.

A data readout system provides pertinent test status and results as either a visual readout or a printed readout for record purposes.

- **Q-9 checkout capacity**—Other features of the system include an auto check of programed actions as executed against the tape through a feedback system; an automatic parity check to detect tape error due to wear, misuse or improper preparations—as well as a capability of self-checking the entire set to insure proper operation or to locate a fault to a replaceable module or part.

The Q-9 has a capacity of selecting up to 2000 test points for measurement and may include up to 300 channels for stimuli control through the test adapters. By adding an additional bay, the equipment is multiplexed by a factor of ten for *Skybolt* and has a capacity of 20,000 test points and 3000 stimuli control channels.

When *Skybolt* becomes fully operational in 1964, the Q-9 will be used with specific adapters for factory, depot and base, test or checkout. This equipment combined with a missile simulator and built-in self assurance tests in the aircraft mounted equipment help assure that the *Skybolt* system will meet the exacting SAC requirements. ■

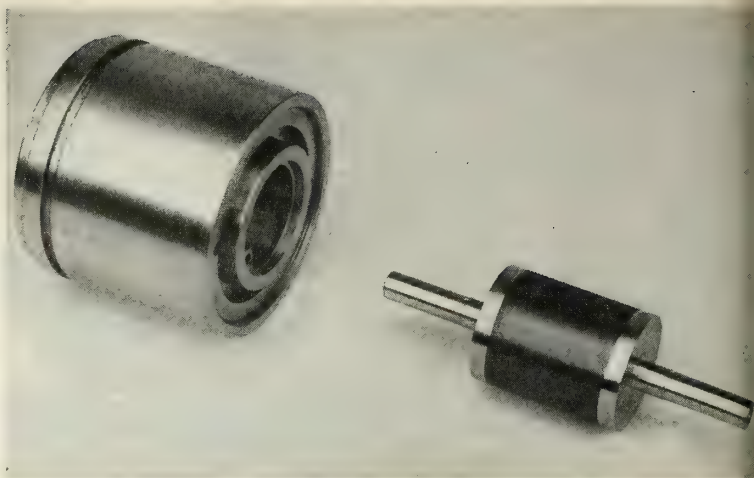


### To Teach Sailors ASROC

INSTRUCTOR'S CONSOLE for ASROC trainer gets final check at Minneapolis-Honeywell Ordnance Div., Duarte, Calif., prior to shipment for installation at Norfolk Navy base. Tactical situations involving the ASROC antisubmarine rocket are established, monitored and controlled by instructors at this master console.



*STATOR and permanent magnet rotor of a Hall-effect synchro transmitter*



## Progress Report on Hall-effect Devices

**Kearfott leap-frogging  
shortcomings of wound ro-  
tating components**

**by Sigmund Harac**

*Group Leader  
Kearfott Div., General Precision, Inc.*

WOUND ROTATING components are prominent and significant in modern computing, control and data transmission systems. However, even though there have been substantial improvements in the design of these components—and the improvements are continuing—there are inherent limitations as to the extent to which wound rotating components can be enhanced in reliability, size, accuracy and versatility.

One of the major limitations on reliability is the wear in the brushes and slip rings. Accuracy is limited by the presence of quadrature components, which prevent servo error signals from reaching null conditions, as well as generated speed voltages. The speed-voltage effect—a function of the ratio of rotating speed to carrier frequency—affects both the amplitude and phase of the output voltage and therefore introduces error into both the in-phase and quadrature components.

• **Wound component limitations—**Accuracy requirements limit the extent to which the size of wound rotating components can be reduced. Temperature dependence constitutes a further operating limitation, and significant deviation from normal operating temperatures generally results in shifts in the electrical zero point—accompanied by degradation in electrical error.

The operable frequency range is generally quite narrow. For example, a synchro designed for 400-cycle operation undergoes a derating in excess of 10 to 1 when operated at an excitation of 60 cycles. Operation of the 400-cycle unit at frequencies several times above the design frequency is again unfeasible.

In view of all of these limitations Kearfott has conducted development work for several years in the area of solid-state rotating components, based primarily on the Hall effect. The components are designed to overcome all

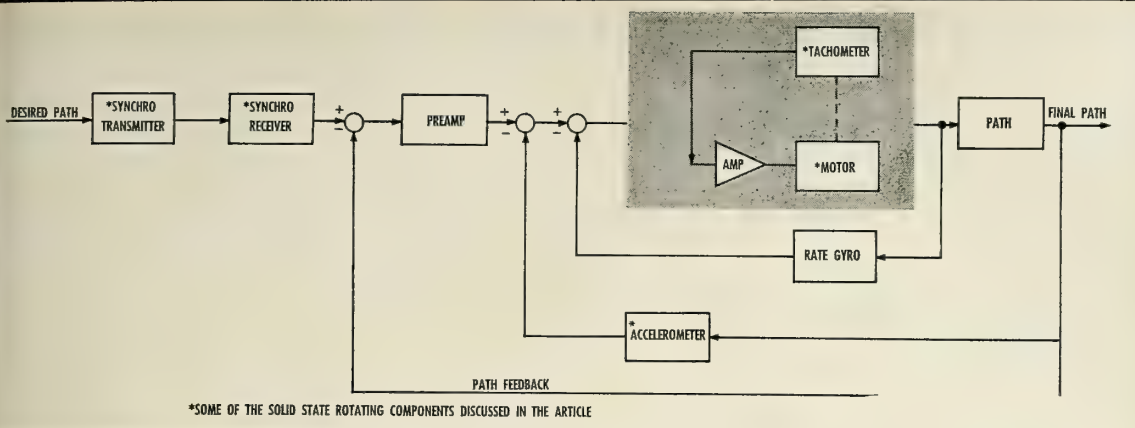
the limitations of the wound devices. They are being constructed to operate without brushes or slip rings, and will have negligible quadrature components and speed-voltage effects. Their temperature dependence can be greatly minimized, and they can operate over a wide range of frequencies. In addition they can be made smaller and cheaper than their wound counterparts.

• **Hall effect described—**This phenomenon occurs when certain materials are subjected to a control current and a transverse magnetic field, with the result that a voltage is generated at right angles to both the current and field having a magnitude proportional to the vector product of the current and field. This effect came into its own with the advent of modern semiconductor materials, whose parameters are such that the output voltage is raised to a useful working level, and which permitted the elevation of the Hall effect from a laboratory curiosity to a powerful design tool.

The Hall-effect generator—the heart of the solid-state rotating component described herein—consists basically of a slab of semiconductor material with a pair of electrodes for the introduction of control current and a transverse pair of electrodes for the Hall voltage output.

By placing the generator in magnetic fields and varying the overall configuration, it is possible to simulate, and improve upon, the performance characteristics of conventional wound rotating components. The Hall-effect generator acts as the transducing element, and since it is essentially non-inductive and non-capacitive in nature, no significant quadrature components or speed voltages are generated as it is rotated in the magnetic field.

• **Material selection important—**By selecting the proper semiconductor material—doped to the proper impurity



BLOCK DIAGRAM of airplane pitch steering control system.

concentration—it is possible to obtain operation over very wide temperature limits. Generally speaking, the selection of the material and doping concentration depends on the specific end use, and normally represents a compromise among parameter requirements such as voltage output, temperature dependence, magnetoresistance properties and output impedance.

The materials most frequently encountered in commercially available Hall-effect generators are indium antimonide, indium arsenide and indium arsenide phosphide. Germanium is the material most commonly used in the special generators developed at Kearfott for use in solid-state synchros for the Bureau of Naval Weapons.

At a fixed-frequency operating field, the Hall voltage output frequency will be determined by the frequency of the control current. The device will operate without significant derating over frequency ranges approaching the megacycle range. The same solid-state resolver, therefore, can operate equally well at dc and 10kc by simply varying the input control current from dc to the higher frequency.

The solid-state rotating component can be constructed with a stationary field structure and rotating Hall-effect generator, or vice-versa. In the latter type of construction, it is possible to replace the electromagnetic structure with a ferrite permanent magnet, and thus eliminate the requirement for brushes and slip rings. The permanent magnet must be magnetized in a special manner in order to ensure the correct flux distribution in the air gap.

#### • Components under development

—Among the many solid-state rotating components in various stages of development are synchros and resolvers, brushless dc motors, tachometers and accelerometers. The synchros and re-

solvers generally consist of ferrite rotors and Hall-effect generator stator assemblies. The output from the generator varies sinusoidally as a function of shaft rotation because the component of the magnetic field normal to the control current varies as a sinusoid. By properly positioning these generators with relation to the field, it is possible to obtain a sine output from some transducers and cosine output from others.

These units are not intended as direct field replacement for existing precision wound components because, with the present state of the art, the output levels are substantially lower than in the wound counterpart. In addition, there are impedance matching problems. Rather, the solid-state components are envisioned as building blocks in overall solid-state control systems, incorporating the various operational advantages described above.

• **Design considerations**—The development of solid-state rotating components introduces several special design consideration and unique problem areas. It has already been mentioned that the output voltage levels are lower than those of similar wound components. Specifically, the output voltage is on the order of several hundred millivolts. This can be increased by judicious selection of the semiconductor material, dimensional variations, selection of improved generator shapes and over-all configurations and the use of associated Hall-effect amplifiers.

The electrodes must be specially attached to insure proper ohmic contact, and they must be specially aligned and trimmed for minimum misalignment zero-field voltage (an output across the Hall terminals in the absence of a magnetic field). The magnetic circuit must be of specially treated material and of special construction in order to eliminate hysteresis effects and saturation of

the magnetic path.

The semiconductor material, and its impurity concentration, must be carefully selected to minimize the effects of magnetoresistance—the change in internal resistance under the influence of the magnetic field. Although this effect can be used in the development of certain Hall effect devices, it should be minimized in the construction of most semiconductor rotating components in the interests of improved linearity and accuracy. Among the factors to be considered in achieving this effect are the proper axis of rotation for the Hall-effect generator and crystallographic orientation of semiconductor material.

Generators for use in the construction of semiconductor rotating components are already in production. The current ones incorporate slabs of germanium; others, in various stages of development, use other semiconductor materials such as silicon and gallium arsenide. Of particular interest in the area of Hall-effect generators is the development work in progress on semiconductor film deposition.

• **Developmental models**—Although prototypes of several semiconductor rotating components have been constructed, this line is not yet in full production. Models of the brushless motor and of several different solid-state synchros and resolvers have been assembled and have been undergoing evaluation tests for quite some time.

These tests have proven the feasibility of the semiconductor approach.

Several Hall-effect resolvers have been tested and most of the anticipated advantages have been verified. In accuracy, these units are comparable to the more precise line of wound synchros. Continuing development is aimed at matching the performance of wound components with accuracies of better than one minute of arc. \*\*



# Launch Gear for Minuteman Keeps Pace

**Autonetics reports launch and checkout equipment is fully integrated despite crash-program pressures**

TO PROPERLY CARRY OUT the objectives of an R&D program, the full operational mechanization of the ground support equipment should be evaluated as well as the flight hardware.

Too often ground equipment has been a tag-along necessity, receiving too little information too late to do anything but compromise between what should be done and the calendar.

Fortunately, the *Minuteman* launch and checkout equipment, according to its contractor, Autonetics, has been very closely integrated with airborne design since the early definition stage, even though the program was on a crash basis. For this reason, although this equipment is not yet operational, requirements for the weapon system have provided the primary design criteria.

The challenge to the design engineer of providing instant retaliation and continuous operation was further sharpened by the concurrency of R&D flight test with operational fabrication.

## • Launch and checkout equipment

—The *Minuteman* launch and checkout equipment—designated as Autonetics Model C18A (G&C Field Test Set) and Model C18B (Remote Control and Readout Set)—consists of two separate consoles, each approximately four feet wide, three feet deep, and six feet high. The sole connection between the two consoles is a digital data link consisting of three pairs of twisted wires. All control, command and readout information between the airborne G&C system and the R&D launch control center, or blockhouse, passes over this link.

Some of the differences between the R&D launch equipment and the operational launch equipment should now be discussed.

From a cost reliability view, it is necessary to keep the electronics-part count at the operational silo at an absolute minimum commensurate with a high confidence factor for successful flight to the target. For this reason the C18A contains not only the minimum circuitry to command the airborne computer into its various modes and to assess the results of the computer outputs, but considerable analog equipment as well.

The primary purpose of the analog-type equipment is to provide an independent series of tests to define a satisfactory or unsatisfactory airborne G&C system. To date, these independent tests have without exception verified the go or no-go condition of the G&C system as defined by the minimal operational type tests.

In the operational silo, the Autonetics Model C53 Guidance and Control coupler houses the electronics for all test, monitor and sequencing func-

tions directed to the G&C system. The G53 circuitry has been packaged within approximately one and one-quarter drawers of equipment.

The coupler is capable of self-test and self-fault isolation. Each plug-in drawer and all wiring and connectors can be removed and replaced during standard maintenance periods, eliminating the necessity for ever allowing a soldering iron in the silo to service the equipment.

The plug-in modules, or etched circuit boards, within three drawers of the C18A are those which were repackaged into the C53 coupler. In many cases individual circuits were improved through an intensive design review program. The circuit interface with the missile has remained unchanged.

The functions of the initial turn-on sequence and filling of the airborne computer, performed by the C18A, are van-mounted in a new console for the operational program. Various optical alignment equipment and personnel baggage are also housed in the van.

• **Operational requirements**—Before discussing the detailed design features of the launch and checkout equipment, the system requirements should be reviewed very briefly:

—Fully automatic checkout and launch sequencing functions within 30 secs. total elapsed time.

—Remote operation and readout capability from initial turn-on through launch.

—Compatible operation for laboratory, system integration, missile assembly building, sled testing and launch from either pad or silo.

—Complete analog testing to verify operation go or no-go tests.

—The complete design philosophy for the operational hardware to be proven in R&D equipment.

• **System operation**—All commands originate from the C18B control and readout console. The command is initiated by a pushbutton which generates a 6-bit digital word which is then transmitted in a serial fashion to the C18A G&C Field Test set. At the C18A the command code is translated into a test signal or series of test commands to the airborne G&C system. The diagram above indicates the functional interface connections between the C18A test console, the missile and certain other pieces of ground equipment.

Character input lines, consisting of six wires, are used to fill the computer memory from the tape reader and tape-reader-control electronics in the field test set. The six lines transmit four character bits, a timing bit and a parity bit, filling the computer memory with

(Continued on page 53)







# INNER SPACE FOR SALE

A lot of jobs—especially in missiles—need room to complete. It takes inner space to prepare for outer space. It takes skills and long experience to work with metals in the large way some of your jobs require.

General American's Plate & Welding Division has the space, the skills and the experience you need, whether your problem is one or a dozen special pieces, or a continuous operation involving thousands of units.

General American has produced lox vessels, radiation shields, atomic waste evaporators and missile equipment

components. We are known around the world for the tanks we have fabricated and erected—tanks for storage of petroleum products, acids, chemicals and water; tank cars for transportation of any kind of liquid. We are constantly at work on projects that involve cutting, forming, milling and stress relieving of large metal structures. Our background in aluminum and alloy steels is considerable.

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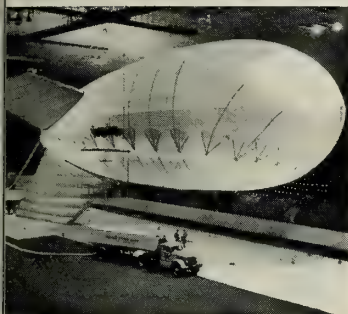
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# 3M MATERIALS MEMO

News of materials for the aerospace industry — selected from the 27,000 products of the 3M Company



## A NEAT BAG OF TRICKS

Even the best of magicians have to keep their audience in the dark to put their tricks over. There are no deep dark secrets or sleight of hand in our brand of magic. In fact, you'll see through it at a glance. The real magic is "in the bag"—if it's made of one of the "SCOTCHPAK" Brand series of transparent films. Whether your problems come in little packages—or loom as big as a "Skyhook" balloon, chances are that you'll find the answer in this product of our Industrial Tape Division.

"SCOTCHPAK" Brand Film is truly a hybrid in that it combines such a variety of desirable properties in one packaging medium. First there's the toughness of a polyester—(tensile strength as high as 10,000 lbs./sq. in., burst strength from 32 to 50 lbs./sq. in.). Then of course there's heat sealability to provide seals as tough as the film itself. All it takes is a pressure of 20-60 psi at a temperature of 300-400°F to do it. You can depend on "SCOTCHPAK" Brand Film for dimensional stability, too—all the way from -70°F to +240°F. Since there's no plasticizer to bleed out, it doesn't become brittle as it ages. Its low water vapor permeability and gas penetration, combined with chemical and solvent resistance, are definite pluses, too, from a packaging point of view. Critical parts can be sealed directly in oil or in special desiccant package constructions.

These same properties can be mighty important in balloon construction, too. And for special heavy duty applications, like air inflated buildings, "SCOTCHPAK" Film is made with nylon reinforcement (tensile strength = 12,600 lbs./sq. in.). Can you use more data on "SCOTCHPAK" Film? Clip the coupon and receive the whole package.

## WE'VE GOT A SYSTEM

It's not likely to help you make a killing on the ponies or clean up at the dice tables, but it's a cinch to work and save you money by cutting paperwork costs. Conceived and tenderly nurtured by our "Thermo-

Fax" Copying Products group, this system is a whiz at numbers—numbers like 25 permanent white bond-weight copies from a single original and as little as 2¢ per copy.

Equally interesting is how the "Thermo-Fax" Brand Systems Papers work. There are two papers—"A" and "B". These together with any standard "Thermo-Fax" Copying Machine make up the whole "system". The process starts by typing, writing, printing, or drawing your data on the type A paper, just as you would ordi-



nary stationery. Next, the type A sheet original is run through the "Thermo-Fax" Copying Machine with the white bond weight type B copy paper. Except for being able to repeat this step 5, 10 or even 25 times, that's all there is to it. This places a short-run reproduction system right in the hands of your secretary—or laboratory. No need to bring someone else into the act.

Other factors worth noting: The individual copies are all sharp and clear—look so much like originals, everyone gets a good copy. Remember too that the type A paper can be printed as one of your special forms or letterheads so headings and lines, etc., will also reproduce. It could even be used as a chart paper for original recording of data which can later be reproduced. Why not make this system a part of your operating scheme?

## GET YOUR (kilo) CYCLES ON THE RIGHT TRACK

When handling of those kilocycles begins to be a vicious cycle and data processing operations jam up like Labor Day traffic, don't just grit your teeth. There is a way to get past the roadblock of conventional magnetic recorder/reproducer limitations. That way is the all new G-100 unit produced by our Mincom Division.

Setting a new standard in versatility and ease of operation, the G-100 can put your data on a clear track in a hurry. As a matter of fact, it offers you up to 14 tracks for information, plus a separate voice annotation track—all on a single modular rack, mind you. And it makes recording of either analog or FM information a real breeze. With equal ease and confidence, you may record static test information in the comfort of your own laboratory, or acquire data from dynamic operations high in the sky.

At a tape speed of 60 ips, the G-100 has a bandpass of 200 cps to 300 kc analog modules and dc to 20 kc with FM modules. A push-button selection of six speeds from 3 1/4 to 60 ips gives you a speed reduction ratio of 16 to 1 with no bothersome belt changes to plague your patience. At the lower speeds, the lower frequency response is extended to 50 cps, and all six speeds are phase-equalized to assure faithful reproduction.

Other plus features of the G-100 include greater dynamic range, a built-in monitor switcher, and built-in calibration so that you may preadjust the recorder to the incoming signal amplitude. And don't overlook Mincom's exclusive dc tape transport. Another premium of the G-100, it gives you freedom from fear of outside power fluctuations.

For more details about this attractive package, just check the box below.

3M Company, Missile Industry Liaison—Dept. VAB-91  
St. Paul 6, Minn.

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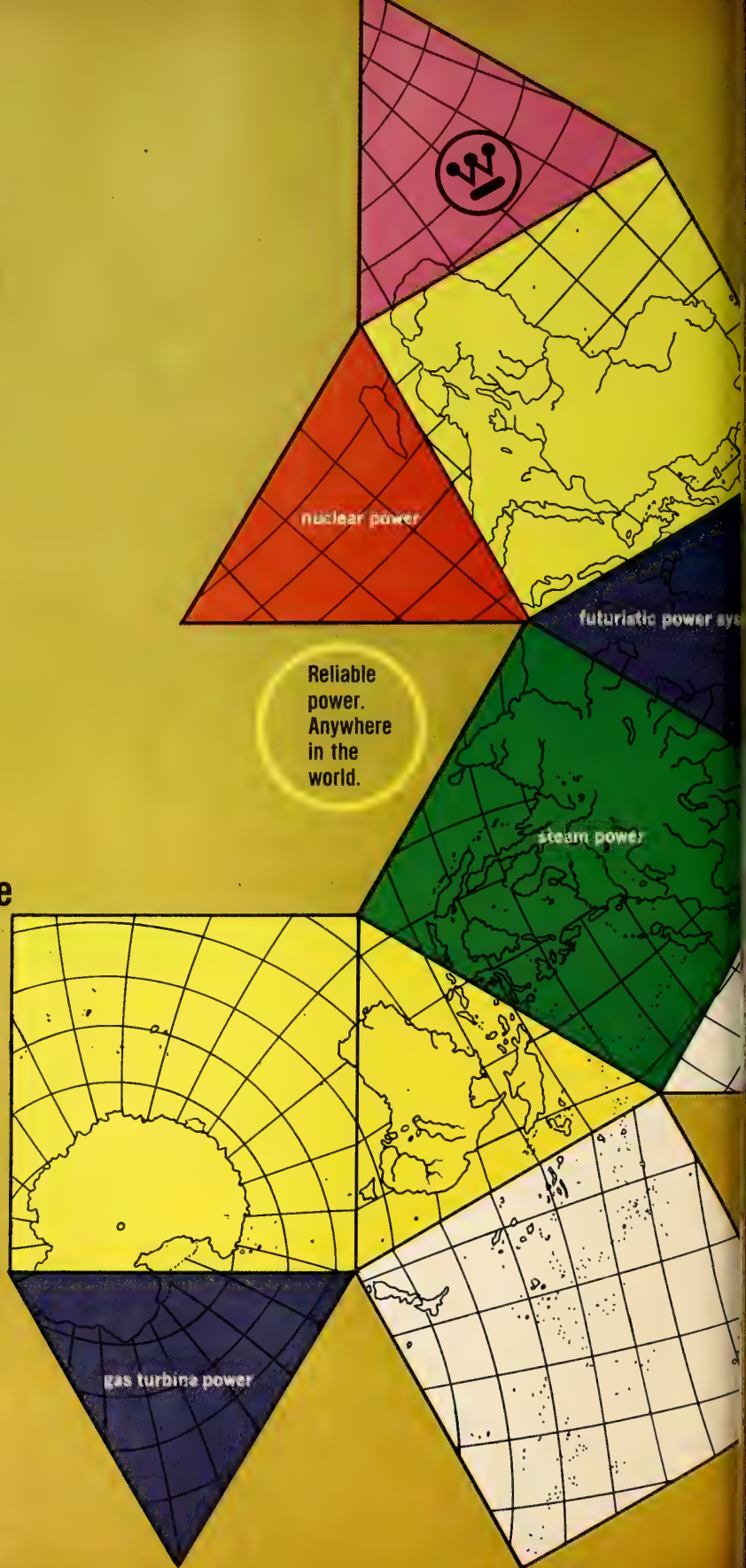
"SCOTCHPAK", "MINCOM", AND "THERMO-FAX" ARE REGISTERED TRADEMARKS OF 3M CO., ST. PAUL 6, MINN.

## Missile Industry Liaison

**3M**  
COMPANY



**Military  
ground  
support  
power  
apparatus  
from  
Westinghouse**



Power problem? For ground support equipment? Military or aerospace? How big? How small? Contacted Westinghouse?

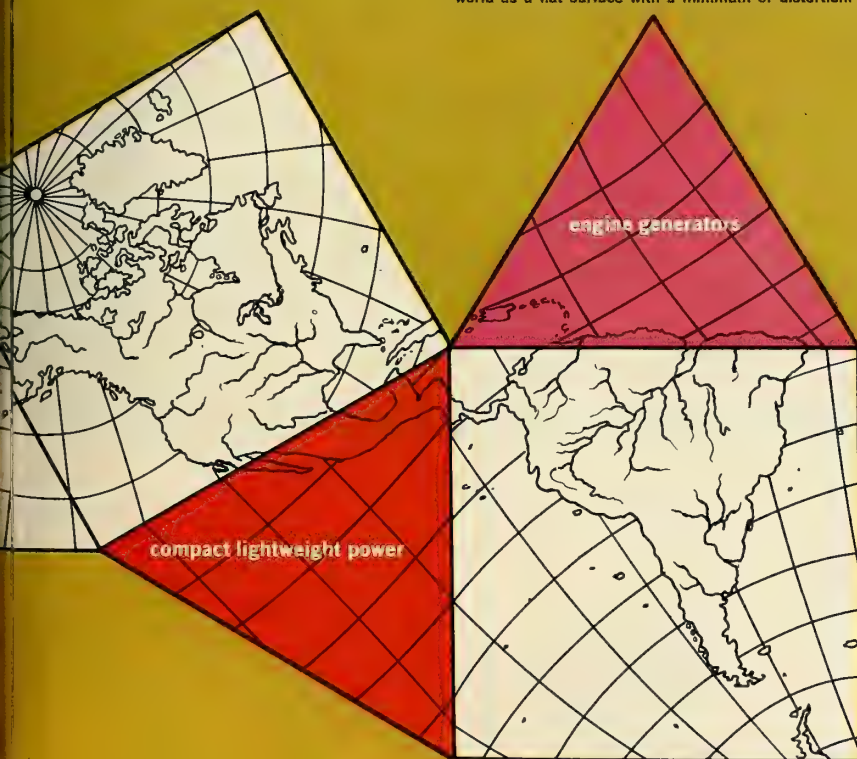
Westinghouse can help you overcome your power generation problems. In any climate. Any environment. Anywhere in the world. With turbines. Condensers. Pumps. Valves. Water conditioning systems. Transformers. Switchgear. Regulation and distribution equipment.

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So bring Westinghouse in early. Consult your Westinghouse sales engineer. Write for helpful product data. And state your specific ground support power problem. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

J-92520

Note: Illustration is the Dymaxion projection of the globe by R. Buckminster Fuller. It depicts the spherical world as a flat surface with a minimum of distortion.



Westinghouse



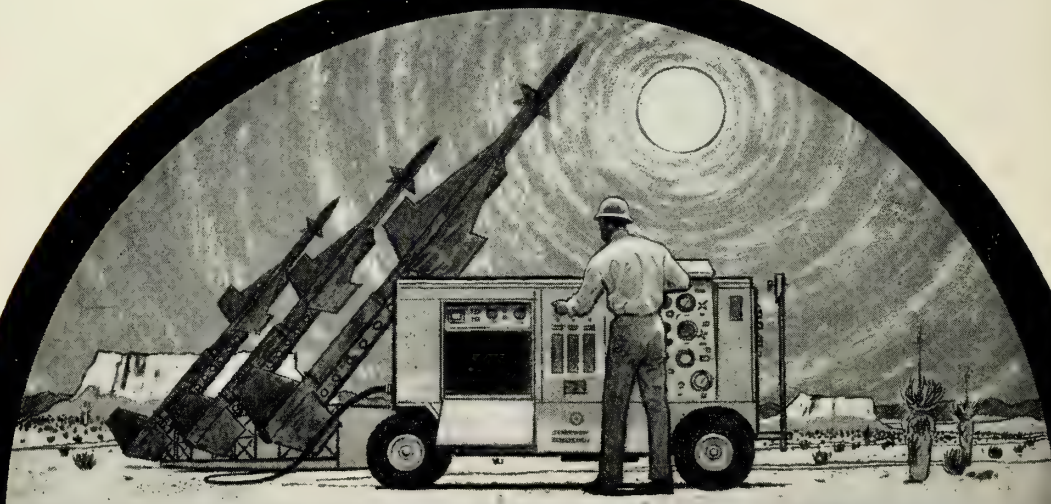


This slotted-blade vaneaxial fan design represents one of many special fan models available at Electric Boat Division for applications where small size, light weight, long maintenance-free life and low structure-borne vibration are critical factors □ At lower speeds and with smaller tip diameters than conventional fans, these turbo-slot fans produce the same air flow and pressure rise by controlling the flow of air over the surface of the rotating air-foil □ Lower speeds extend the service life of the vaneaxial fan and reduce the airborne noise and structure-borne vibration levels □ Smaller tip diameters allow for light-weight design and further contribute to lower airborne noise levels □ Call New London, Conn., Hilltop 5-4321, Ext. 1933, or write Fan Dept. (MR), Electric Boat, Groton, Conn.

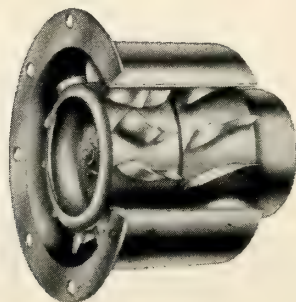
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A DIVISION OF  
GENERAL DYNAMICS

**GIMMID**



NEW FROM ELECTRIC BOAT  
TURBO-SLOT FANS FOR MISSILES & SUPPORT EQUIPMENT





(Continued from page 47)

characters in the octal number system at a rate of 200 characters per second. The computer memory, when filled, contains the ground program and flight program including launch site and target coordinates.

Four lines—called the program control lines—are used to send all commands from the ground ordering the computer to initiate given portions of its program. Commands are in the form of binary codes. Another set of lines transmits information from the computer to the ground equipment.

This set of six lines—four of which form a decimal number in binary form along with a timing signal and a parity bit—transmit two types of information to the ground on a time-shared basis. The first type consists of codes which generally indicate the status of the computer. The second type of transmission is numerical data to be printed out at the C18B readout equipment in the blockhouse.

There are certain discrete inputs to the computer which enable the ground equipment to control general modes of computer operation, such as Enable Write, Halt, Master Reset and Disable Discretes. The commands are on separate lines between the C18A and the computer.

Enable Write and Halt commands are used during the computer fill operation in such a manner as to enable the computer to write in its cold storage memory. The Master Reset command will tell the computer to halt operation and restart its operation at the beginning of its program.

The Disable Discrete function is used to insure that the discrete outputs of the computer are in the false state during the periods when power is applied to or removed from the missile. This is desirable because it is impossible to prevent the possibility of random outputs during these periods.

A 2-bit binary signal from the test set—principally a retransmission of information from the autoreflector—holds the inertial platform in the proper azimuth alignment. Also, when power is first applied to the computer guidance system, an overvoltage signal is applied to the gyro motors to quickly attain sufficient speed to enable operation of the air bearings.

The nozzle drive signals from the ground field test set are also directed to the guidance compartment since it is in this area that the nozzle signals are switched to the various stages by the computer. Both sinusoidal and step function test signals are injected into the missile at this point.

Hydraulic pressure and a reference voltage are measured on each flight con-

trol system at the beginning and end of each nozzle unit test. These voltages and pressure analogs are printed out as part of the test data on the C18B in the blockhouse.

During step function tests the nozzle deflection voltage analog is converted to a digital value and transmitted to the readout equipment. During sine checks the nozzle pickoff signals are returned to the servo analyzer.

#### • Associated support equipment—

The autoreflector—located approximately 500 feet from the missile—is principally an optical instrument which transmits a chopped beam of light through a window in the guidance compartment to a mirror mounted on the platform. The return light beam is compared in phase with the transmitted one and the results of the comparison are converted to electrical signals.

These signals are then transmitted through the ground test set to the airborne computer where they cause the computer to servo the platform into alignment with the light beam. Azimuth alignment is thereby referenced to the autoreflector position.

Another piece of auxiliary equipment is the guidance cooling unit which is comprised of a refrigerator, control system and a pump circulating chilled water through the guidance compartment. The control system senses the output of a thermistor in the helium stream within the guidance compartment and controls the flow of water to maintain the compartment temperature within very close limits.

A sequencer and monitor is used during the final 30-sec. countdown and, at the beginning of this period, it sends a signal to the ground test set indicating that the 30-sec. countdown is to start. Near the end of the period the ground test set sends a signal back to the sequencer and monitor indicating that the computer has entered its flight mode. Also during this final countdown, ground power to the missile is sequenced on and off by the ground test set.

All of the control and readout facilities required to test and launch the guidance and control portion of the *Minuteman* missile are contained on the two panels of the C18B Remote Control and Readout Set. The two control panels are placed side by side with the various controls and indicators arranged in such manner that they can be conveniently operated by one or two operators.

This concept of fully automatic checkout and launch sequencing has enabled the Air Force's *Minuteman* program to gain more than a year toward its all-important operational readiness date. ■

# Sending RAW DATA from MARS!

Unprecedented opportunities are now available for communications engineers and system design engineers at Remington Rand Univac in St. Paul on MARS—the Mobile Atlantic Range Station project.

MARS is a precision tracking system involving the Univac 1206 Real Time Computer and Univac data handling sub system.

From shipboard installation, millions of raw post flight information bits will be transmitted to Cape Canaveral. The career opportunities in working on such a challenging project are obvious, so we urge all qualified applicants to investigate these permanent openings which are now available.

## SYSTEMS DESIGN ENGINEERS

will be required to develop systems integration procedures between data gathering and data handling systems. Positions include circuit development work and the logical design of high speed computer elements. Engineering, Math or Physics degree with extensive systems experience.

## COMMUNICATIONS ENGINEERS

should have EE degree, plus 3 or more years heavy experience in high speed, long range digital transmission systems. Experience with missile range information accumulation and transmission valuable. Should have RF experience.

Additional openings are also available for PROGRAMMERS and SYSTEMS ANALYSTS at both St. Paul and a new facility being established in the Cocoa Beach, Fla., area.

Send complete resume of experience and education to:

R. K. PATTERSON

**Remington Rand**  
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DIVISION OF SPERRY RAND CORPORATION  
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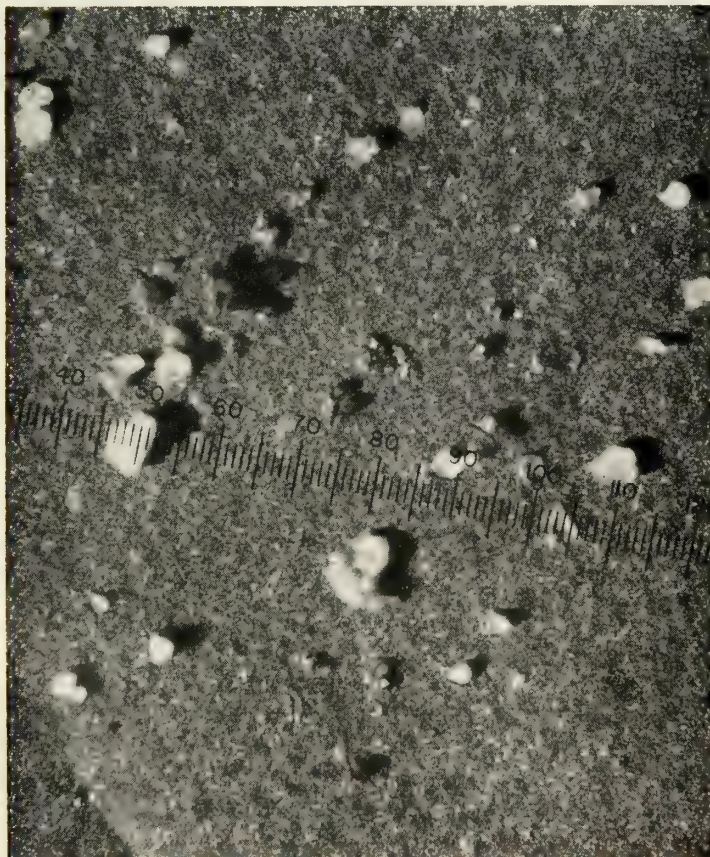
All qualified applicants will be considered regardless of race, creed, color or national origin.



# Cutting Cost of Clean Hydraulic System Parts

**Vickers' work shows that new cleaning techniques, parts and materials can control contamination better, cheaper**

by **A. B. Billet** *Senior Staff Engineer  
Aero Hydraulics Division  
Vickers, Inc.*



**ACTUAL PHOTO** of filter-trapped particles, magnified 100 times, shows amount of foreign material collected from one square for the particle size count.

FROM A DOLLAR standpoint, the fantastic campaign against dirt in missile hydraulic systems may be making components too clean.

It is now evident that a re-evaluation of contaminant control procedures could pay off by improving system performance for the same cost.

Without compromising the cleanliness of missile hydraulic systems, greater emphasis on the contaminant tolerance of system components will help insure maximum reliability, even though the reliability requirements have advanced to a point which was not believed practical a few years ago. A high level of system and component cleanliness has been a major factor in making successful missile flights and space shots as commonplace as they are today.

During the early part of World War II, contamination control involved little more than the simple expedient of installing filters in the hydraulic system, often of the 25 micron type. As performance requirements increased, this was rapidly changed to an industry standard of 10 micron nominal and 2-micron absolute. Now, in missiles and space vehicles, 1- and 2-micron filtration is required, with a rigid pre-system operation cleanliness requirement.

New ultrasonic cleaning technique and high-temperature and high-pressure flushing techniques are used to obtain a high level of component and subsystem cleanliness. Final testing, evaluation and assembly is performed in special, surgically clean rooms. These environmentally controlled rooms permit extremely close control on wear environments, access of personnel, type of tools and the processing of materials. They are pressurized and air filtered to take out 1/10th micron dust particles.

#### • Contamination measurement —

Accurate measurement of contaminant level is a prerequisite for effective contamination control. Approximately five years ago Vickers helped develop the visual patch standard, in which the total contaminant from pump and system filters is placed on a filter paper and visually compared to an established standard. The criterion of measurement is the amount of metal and dirt particles and the color.

A more recent development involves microscope examination of an 100 cc sample of fluid removed from the component or system. Contaminant from this sample is placed on a membrane type filter paper, and the actual particles of contaminant are counted and classified by size under 100X magnification. Some systems require a cleanliness level such that contaminant particles down to 5 microns must be counted. In some cases, a laboratory

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Here's a really rugged, powerful, dependable, one-shot switch so compact you can hold it in your fingertips.

Actuated by Atlas squibs, these switches operate on powerful chemical energy released by electrical signal. They are used in space vehicles, test sleds, missiles, and rockets, replacing larger, heavier, and more complicated relays and breakers.

These switches withstand temperatures up to 500°F., vibrations up to 2000 cycles/sec., shocks as high as 35000 Gs., and fit a wide range of remote control switching applications. Certain types incorporate pyrotechnic time delays for sequencing operations or delayed action.

Atlas Research and Development teams—backed by years of practical experience in the field—are constantly finding new applications and developing new designs. Technical literature is available on Atlas squib switches, actuators, electric matches, and other explosives or squib devices in the Atlas product line. Write today regarding products or projects.



OM SERIES SWITCHES



IMT114 MINIATURE  
PISTON ACTUATOR



IMT111 TELESCOPIC  
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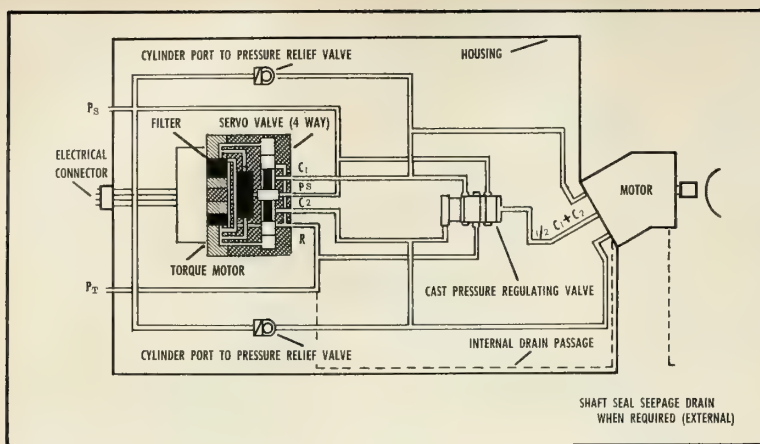
IGNITERS

MEETING RELIABILITY CHALLENGES BY ELECTRO-CHEMI-MECHANICAL RESEARCH

# ATLAS

CHEMICAL INDUSTRIES, INC.  
ORDNANCE MATERIEL DEPT.  
WILMINGTON 99, DELAWARE





SCHEMATIC OF Vickers integrated servo-motor, which puts parts in single housing.

technician requires 4 to 5 hours to count the number of minute particles on a single patch sample.

A system and its related components are carefully cleaned and an optimum cleanliness level established before it is put into service. Once operation begins, however, contamination is too often allowed to build up without corrective measures being taken. To insure satisfactory field operation, it is imperative that a complete and effective field contamination measuring procedure be defined at the start of a program. This procedure must be effective in the following areas:

- Measuring system contamination.
- Evaluating contamination results.
- Taking corrective action when contamination is above the maximum limit.

#### • Contamination common sense—

Efforts to control and measure contamination represent a sizable investment in time and money. Although the assurance of maximum reliability warrants top priority, there is justification for asking—"Are we getting optimum results from this investment?"

Therefore, to achieve optimum results, it would seem advisable to establish several zones of cleanliness levels for a missile system and its supporting equipment—i.e., determine the most critical area and establish the rigorous contamination level required for that area. Other areas requiring less rigid control would then be determined and correspondingly lower requirements established.

The idea here would be to relax somewhat the contamination control efforts in an area with relatively low cleanliness requirements — reservoir, non-rotating parts, etc.—and transfer some of this attention and effort to the area or areas where more rigid control is required. These areas include the servo valve, where every precaution is justified, and ground support equipment

where past experience shows more attention is required. Three zones—the servo valve actuator, the hydraulic pump and associated GSE—should be singled out for special attention.

The first critical part—the servo valve actuator—translates hydraulic horsepower into mechanical work and actually controls the missile flight control system. A few grains of dirt here could cause missile destruction.

It is immediately prior to this area that finer system filtration is required—specifically, one-micron filters. It is in this area that all contaminant particles, down to 5-micron size, should be inspected and counted from fluid samples.

As outlined below, considerable progress has been made in designing and building pumps that are tolerant of contamination. More attention should be given to applying this same realistic approach in the design of servo valves. Suggested steps that could be taken to improve the contamination of servo valves include:

- Further studies to determine optimum valve and spool materials.

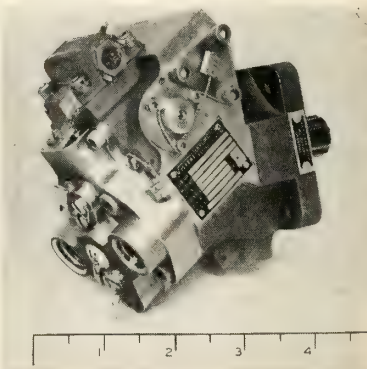


PHOTO of integrated servo-motor package shows how eliminating lines between motor and manifold reduces contamination areas.

—Use of high force level on the servo valve output stage.

—Reduced valve spool clearance to keep out contaminants. Design studies would be required with regard to thermal coefficients and the ability to reduce binding between valve and spool.

Contamination tolerance is one of the advantages provided by a new, integrated servo-motor developed by Vickers. In this design, the servo valve hydraulic motor and internal relief valves are incorporated in one housing as shown in the above schematic. Elimination of hydraulic lines connecting motor and valve manifold reduces the number of areas where contaminants might be trapped. Also, there are fewer fittings which might contribute to contaminant generation.

• **Hydraulic pump**—Most missile systems call for initial static cleanliness level on the pump. This may be achieved through the procedures mentioned earlier: ultrasonic cleaning, final assembly in a "white" room and high pressure flushing. This effort can be a total loss, however, as the pump generates new contamination in the system during operation. If the pump contaminant generation level is too high, the entire hydraulic system can be quickly contaminated many times beyond its previously satisfactory limits.

At Vickers, detailed studies have been made of contamination generation in pump rotating parts, particularly bearings. As a result, changes have been made in the design of ball and roller retainers which are now available in production bearings of major manufacturers. These changes include use of new materials, improved finish and changes in the retainer dimensions which have produced bearings that generate far less contamination during operation.

Improvements have also been made in the self-aligning characteristics of bearings and in wear qualities of the pump valving surfaces. Special assembly procedures minimize the creation of metal slivers during the mating of parts. Incidentally, use of these special assembly fixtures and bearing heating procedures that make it possible to drop all bearings and spacers on the drive shaft in one operation, eliminates hours from the assembly operation.

Speaking generally, it is useless to obtain an initial static cleanliness level in the system finer than the total system generation level after 10 minutes of operation. If this level is not acceptable from an operational standpoint, then the pump generation level must be reduced accordingly.

Development of the contaminant minimum pump has been paralleled by development of the contaminant tolerant pump. For some systems where con-

mination is known to exist, certain features can be designed into the pump to make it less susceptible to contamination. The Vickers approach to the problem includes various dimensional changes to alter tolerances, the use of ductile iron in the cylinder block and bearing ball retainers, and the use of tungsten carbide plating on mating valve plate surfaces.

It's interesting to note that the contaminant tolerant design, is also, in effect, a contaminant minimum design because it generates very little contamination in its operation. High-hardness materials and well-matched parts minimize generation of wear particles.

• **Ground and static equipment—** This zone would include non-rotating, or non-moving, hydraulic components within the vehicle proper, such as reservoir(s), check valves and accumulators. The cleanliness level of this zone can be lower than that for the other two systems, since two or more filters are used between these components and the final servo control zone. Once the cleanliness level is established for this equipment, however, it must be rigidly maintained.

Ground support equipment warrants much greater attention than it has received up to now. In the past, much of this equipment has included commercial components not intended for critical cleanliness applications. Heavy and continuous contamination has resulted from the use of standard iron pipe, pipe thread compound and castings that were not pre-cleaned. Unfortunately, even the best filters are not efficient enough to fully protect the missile system in such cases.

It is necessary to have a continuous-field contamination check with procedures that will insure frequent and adequate inspections. In a recent study of contamination problems that developed in the field operation of a military system, it was determined that many repeated failures of hydraulic components in the vehicle were due to failure to obtain an adequate cleanliness level following each previous failure.

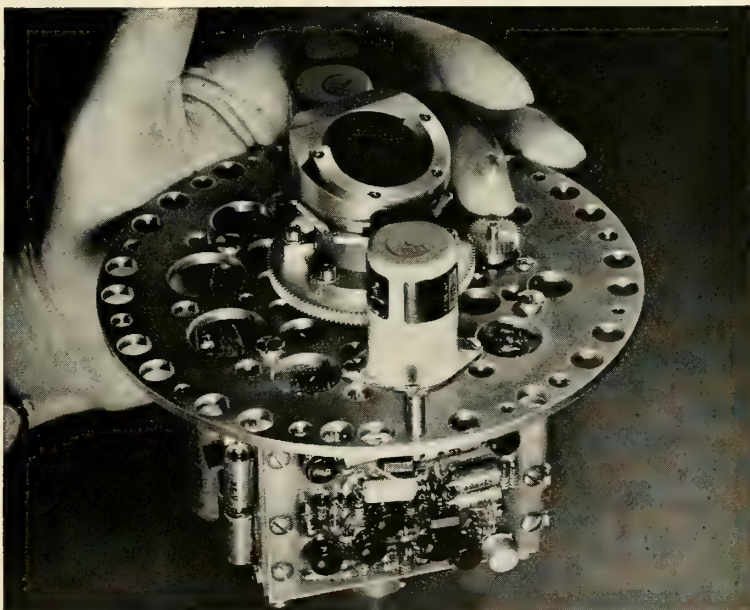
A further inspection of the ground support hydraulic flushing test stand indicated that the filter had not been changed in two years. As a result, the pressure drop became so great through the filter that it had caused complete failure of the filter element. Thus, instead of being a ground means for obtaining a cleaner system, the flushing stand was heavily contaminating the airborne system each time it was used.

Careful planning is required, therefore, in the early stages of GSE design and development. Steel tubing should be used rather than iron pipe, and ultrasonic cleaning specified on many of the more critical components. ■

## Bristol choppers help first U.S. Astronaut maneuver space capsule

Four Bristol Syncroverter\* choppers formed a vital part of the infrared horizon sensors manufactured by Barnes Engineering Company, Stamford, Conn., and carried aloft in NASA's MERCURY capsule by the first U.S. astronaut to reach outer space.

The Bristol choppers function as sensitive phase detectors in the sensors as they establish a horizontal reference plane for the vehicle.



Infrared Horizon Sensor undergoes rigorous optical, mechanical, and electrical checks at Barnes Engineering Co. One Bristol chopper is located in foreground, in front of gear.

**Bristol Syncroverter\* choppers**, noted for low noise, long life and high reliability, are finding a vital place in more and more missile guidance systems, as well as in analog computers, d-c amplifiers, and test equipment for industrial applications. More than 200 models available. Write for complete details.

**The Bristol Company, Aircraft Equipment Division,  
173 Bristol Road, Waterbury 20, Conn.**

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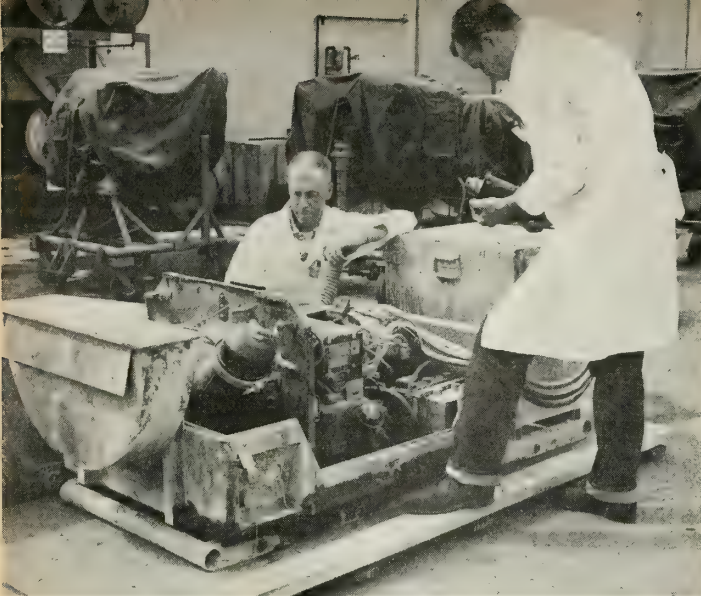
\*T.M. Reg. U.S. Pat. Off. 1-4

**BRISTOL** ... engineers for precision, builds for reliability

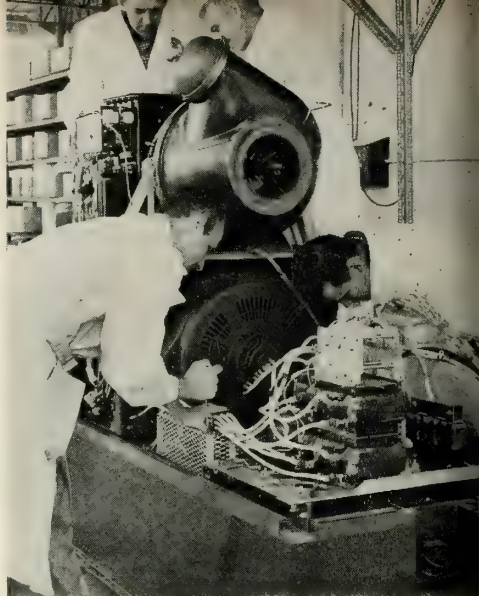
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**CONDITION** of a typical *Sergeant* missile turbine generator set sent back from field use. Units are in production at AiResearch-Phoenix.



**TECHNICIANS CHECK** gas turbine slated for delivery to Army for use in *Jupiter* support.

## GSE MISSILES

# Gas Turbine Ideal for Field Support

**Experience with Jupiter, Sergeant shows merits of small size, light weight, speed for mobile missile systems**

**RULE OUT** minimum size and weight considerations or choose small gas turbine engines for auxiliary power. This basic choice became readily apparent during the development of early tactical missile support systems.

Aside from envelope-weight considerations, its warmup characteristics alone single out the turbine. Swift timing—a prime requirement for tactical mobility—is cancelled by typical reciprocating engine starting and warmup requirements. A turbine's average 15 to 60 seconds from start to load even at temperature extremes of  $-65^{\circ}\text{F}$  is exactly tailored to such requirements.

• **Turbine history**—Turbines—powering such proven, operational systems

as the Army's *Sergeant* and the Army-Air Force *Jupiter* and upcoming on the Army's *Pershing* missile—have already established the logic of auxiliary power turbines for mobile field support requirements.

As a background to the small gas turbine in its missile support role, it is interesting to note that the first successful small gas turbine was not developed until 1946. From this turbine came the first pneumatic starter—the now-almost-standard method for converting pneumatic power to mechanical power through an air turbine starter.

In the missile support field, AiResearch division of the Garrett Corp. began work with the Army in 1957 on the *Redstone* missile. The turbine concept was sold to the Army—only to have its order canceled by termination of development funds. Next came the *Jupiter*. However, only with the *Sergeant* did turbines really get an opportunity to prove themselves both tactically and logistically.

A spare turbine for each *Sergeant* system was initially planned. However, as the turbines gained test time in the

program, this requirement was dropped. And, after long and careful evaluation AiResearch turbines were chosen for the *Sergeant* because of their performance reliability and growth potential.

• **Jupiter-Sergeant experience**—The first actual hardware experience with ground support of a liquid-propellant missile came with the *Jupiter*. With only five months lead-time, a turbine-driver power package to Army specification was built and delivered. This unit produced 100k of 60cps a-c power in a 3000-lb., self-contained, skid-mounted package.

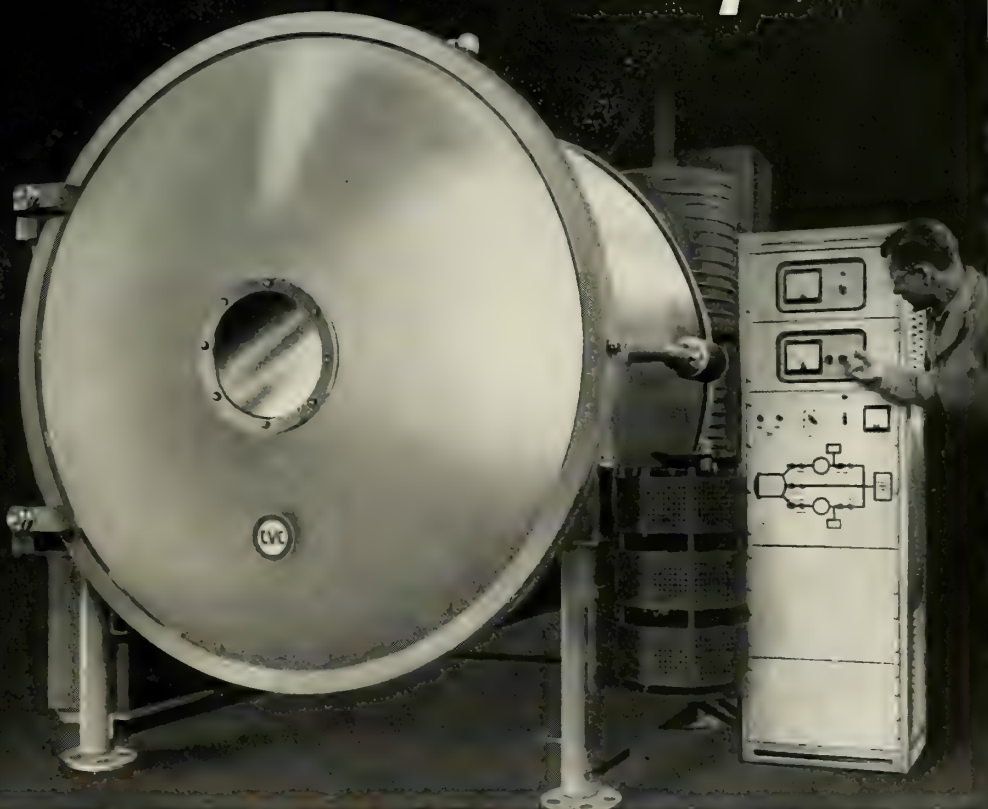
Heart of the *Jupiter* support unit is a 315-lb. turbine producing 225 hp to drive a 1200-lb. alternator. The support unit was designed from modified off-the-shelf equipment and met all the Army requirements for reliability, mobility and cold-weather operation.

While the *Jupiter* turbine unit met all specifications, its addition to the missile system came late in the system design stage. Therefore, the first instance of a missile system completely designed to take advantage of the small gas turbine was the solid-propellant *Sergeant*.

# THIS THERMAL VACUUM CHAMBER (6'x5')

is ready for your space program

## today!



Within this giant chamber entire satellites can experience the extreme thermal environments of outer space.

A new addition to the Aerotest "space room", the chamber illustrated, is the largest operated by any independent testing laboratory in the United States. The chamber has a six foot diameter and a length of five feet. When necessary, five foot sections with additional diffusion pumps may be added. Two 20" oil diffusion pumps and a large fore-pumping system provide rapid evacuation that will keep test time to a minimum. This new unit is now in operation and is ready to take part in YOUR program, today.

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## How common salt led to an uncommon concept in communications.

An unusual new device to increase radio reflectivity, now under development at Northrop's Radioplane Division, may well revolutionize the field of space communications. Called ADSAT (for Anomalous Dispersion Spherical Array Target), it should extend the usefulness of passive communications satellites out to 22,000 miles—the 24-hour orbit.

The germ of the ADSAT idea actually came from early X-ray diffraction experiments with ordinary salt crystals which yielded a pattern of intense bright and dark spots. This hint of resonance with the crystal

lattice led Northrop researchers to attempt to duplicate this effect at radio frequencies—and the first version of ADSAT looked much like a molecular model, with silver-coated ping-pong balls serving as "atoms." The size of the balls and the intervals between them were carefully calculated to resonate with and reinforce the incoming frequencies.

In its present, basic form, the ADSAT satellite is a collapsible, spherical network, 100 to 400 feet across, with the resonant balls at each intersection of the network. It is designed to be launched in a small

package, and inflated in orbit, much like Echo. The reflected signal, however, can be 1,000 times as strong as that obtained from a simple, Echo-type target of equal size.

The development of the ADSAT concept demonstrates once again Northrop's unique ability to visualize problems in space technology, decide what should be done, and come up with solid, workable answers.

**RADIOPLANE**  
A DIVISION OF  
**NORTHROP**

—developed for the Army by JPL and Sperry-Utah.

In this system, by installing turbines on the transporter-erector-launcher and on the guidance vans, it was possible to eliminate three standard 2½-ton trucks which would otherwise have each towed a trailer-mounted, engine-driven generator set.

• **Disadvantages overcome** — with the operational *Sergeant* system, two most often cited turbine disadvantages — noise and fuel consumption — have been put into proper perspective. In an enclosed, attenuated package roughly one-quarter the size and one-eighth the weight, turbine noise levels on the *Sergeant* are less than that of standard Army engine generator sets. As to the second turbine problem, average fuel consumption in a typical *Sergeant* launching has proved to be six to seven gallons total — hardly a serious logistics problem.

Granting the diesel a 2-to-1 advantage in lower fuel consumption over present turbines, the chart above shows that over 48 hours of turbine operation are required before the transport weight, including fuel, cancels out the turbine's initial weight advantage. In addition, the turbines burn the same combat gasoline used by their transporting vehicles.

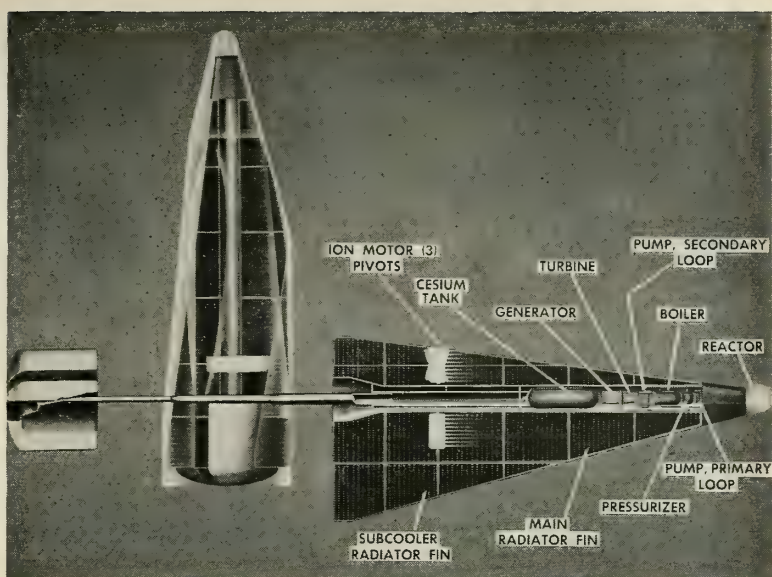
The *Sergeant* missile support GTG (gas turbine generator) is basically a shaft power unit similar to a standard unit. Its output is available through a generator as 400-cycle alternating current — some of which is rectified to give d-c power.

In the *Sergeant* system, two of these units are used. One is mounted on, and powers, the TEL's electrical and hydraulic system. The second turbine supplies current to the electronic guidance van. Removing and replacing either unit is quickly accomplished with the entire enclosure serving as its own shipping container. As many as four enclosed turbines with 3-4 hours of fuel each can be readily transported as slung-load under a helicopter.

Many details of the Army's latest tactical missile system — *Pershing* — are still classified. However, in this system, the Army has again turned to small gas turbines in a much improved and refined *Redstone*-type system. The 2600-lb. *Pershing* turbine power package is capable of producing electricity with two different output characteristics and includes a 3000-psi air compressor and an air conditioning unit.

• **Future developments** — The turbine-powered support packages of the near future are indicated by recent developments in electrical power generation. For example, a 30-hp small gas turbine — currently being demonstrated by AiResearch — directly drives a gen-

missiles and rockets, September 18, 1961



SPACE CAPABILITY of turbines is highlighted by AiResearch work on AF's SPUR.

erator employing silicone-controlled rectifiers. The development for the first time frees the turbine from size, weight and reliability restrictions imposed by the necessity of gearing normal high turbine rotational speed to match generators designed for low reciprocating engine speeds.

The rectifiers allow "pieces" of the 3200-cycle high-frequency electricity generated to be "fitted" together into usable 60- or 400-cycle current. Based on this development an enclosed, tur-

bine-driven generator set is being produced which will be capable of producing 100kw of 60- or 400-cycle electricity. The complete high-frequency set will weigh only about 800 lbs.

Another development — a turbine-driven standard generator set — is now being built for the Army. Featuring flexible, two-piece construction, the set includes a bottom, skid-base enclosure containing a 60-gallon fuel tank, pump and filter, a tool box and drag bar. A second enclosure, mounted on top of

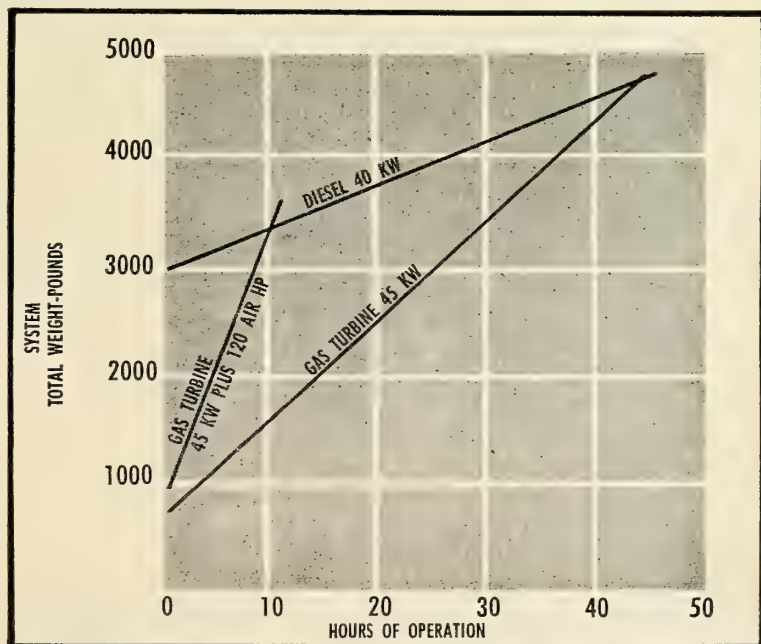
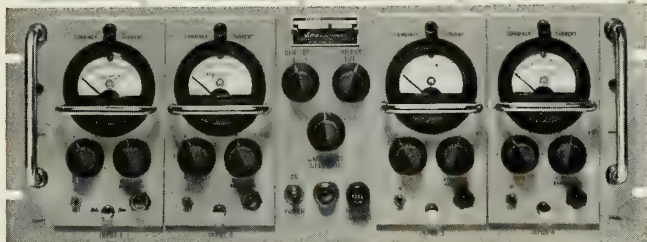


CHART SHOWS it takes 48 hours of operation to cancel turbine's weight advantage.





DCA-1000A DIVERSITY COMBINER. COMBINING ACTION IS OBTAINED BY SAMPLING NOISE OUTPUT OF EACH RECEIVER BY MEANS OF HIGH-PASS FILTERS.



## POSITIVE DATA RETRIEVAL

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Diversity Combiner is designed to handle FM/FM and PDM/FM signals in ground support installations in which up to four receivers with 500 kc and 100 kc bandwidths receive the same RF transmission simultaneously. Signals of the receivers are mixed by combiner into one improved output. The s/n ratio is better than that of any one of equal input, or as good as the best single input. Unit responds instantly to rapid changes in s/n ratio.

Fail-safe circuits assure signal reception at all times. One circuit per input prevents loss of any one of the input signals from causing additional degradation of the output signal. Another circuit guards against complete loss of data should the combiner fail. Each channel has its own plug-in unit, and any one module may be removed for servicing while the others continue to operate. Unit is designed for standard 19-inch relay rack mounting.

Diversity Combiners for non-standard signal reception are available on special order. Where the utmost in exacting communications equipment performance is demanded—Vitro is at work.

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the first and easily removable from the lower section, contains a small gas turbine, a generator, electrical equipment, instruments and other equipment.

With both enclosures assembled, the 750-lb. unit comprises a self-sufficient mobile power set readily transported by air or any standard vehicle. When the bottom enclosure is removed, the turbine easily mounts on a launcher or guidance vans for applications such as the *Sergeant* system.

• **Space applications**—Since it is an air-breathing piece of equipment, the future of the turbine might seem limited to ground applications. However, in the face of a rapidly developing space technology, the turbine has kept pace. Specifically, AiResearch is the prime contractor and systems manager for the Air Force's *SPUR* project (Space Power Unit, Reactor). Designed for space probes in the latter part of this decade, *SPUR* will initially furnish 300 kw—later increase to 1000 kw—at a weight of 8 lbs. per kilowatt.

Gas turbines, then, are approaching the point where their cost of operation will prove as low or lower than comparable reciprocating support equipment. The big factors in this low-cost operation will prove to be much lower maintenance costs for turbines and high reliability—factors considered important in the design of anybody's support system.

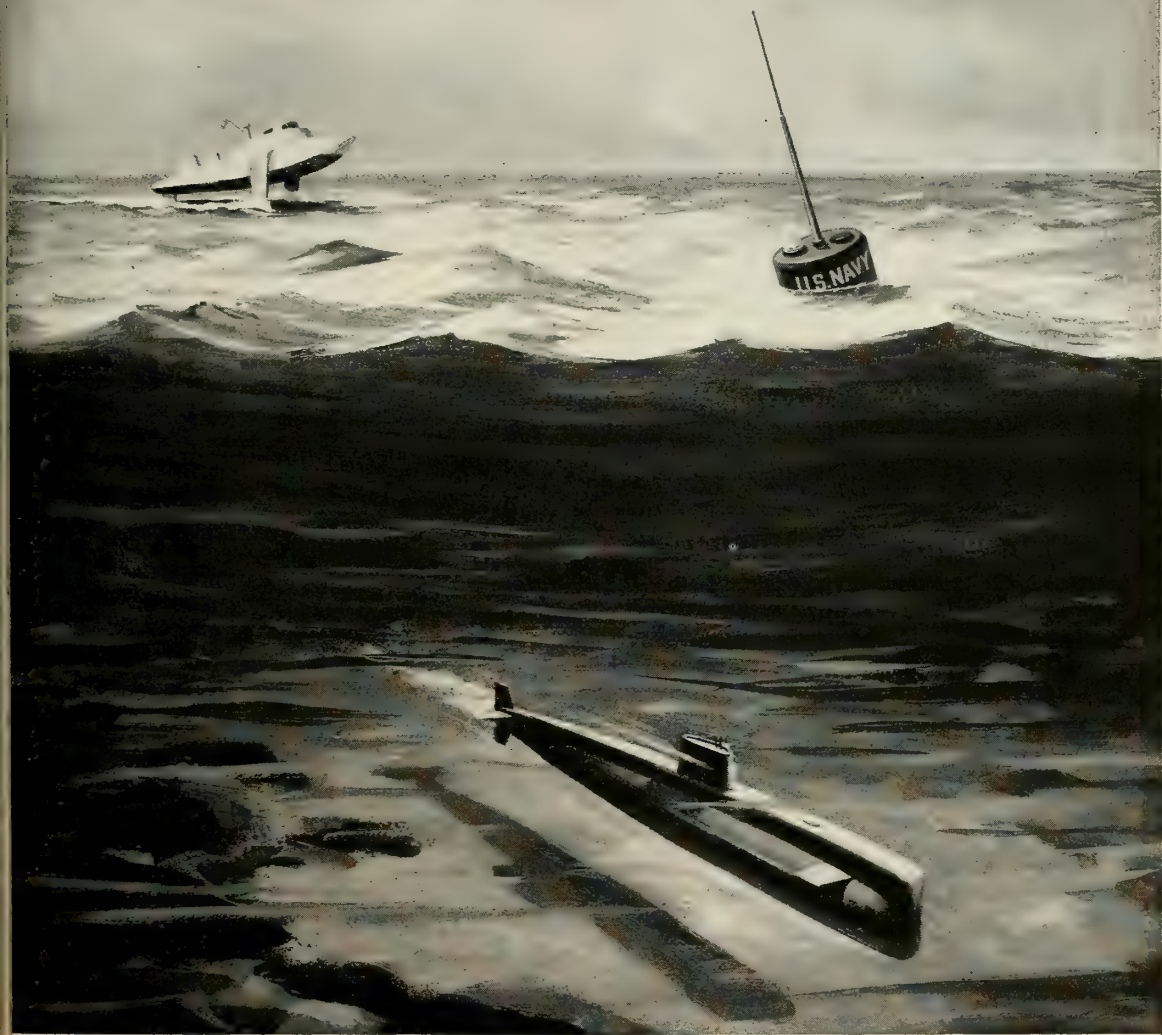
## Burroughs Making New NORAD Command System

A NEW COMMAND and control system—designated the 425-L—is being produced and installed for North American Air Defense Command headquarters by Burroughs Corp.

The new system will collect, process and display air defense intelligence from all Air Force warning and communications networks. Overall system management will be exercised for the AF by the MITRE Corp.—a non-profit organization providing systems engineering and technical direction for the Air Force's Electronics Division.

Although similar to the Burroughs 5000 series computer, the new command and control system is expected to use a Modular Data Processor D825, which in turn uses thin film rather than magnetic-drum memory circuits. The main advantage of the D825 is that each computer schedule itself and initiates master/slave relationships with the other computers in the system as required for optimum parallel operation. High computational capacity is obtained by using all system elements continuously while balancing the arithmetic, memory and input-output modules.

# NEW NAVY... NEW WEAPONS



New naval defense concepts are vital in these days of nuclear submarines and guided missiles. One of these: A destroyer-class hydrofoil boat guided to lurking enemy submarines by remote sonobuoys. Ford Instrument is now working to turn this new concept into operational hardware . . . one of the most recent efforts in our 46 years of service to all branches of the armed forces.



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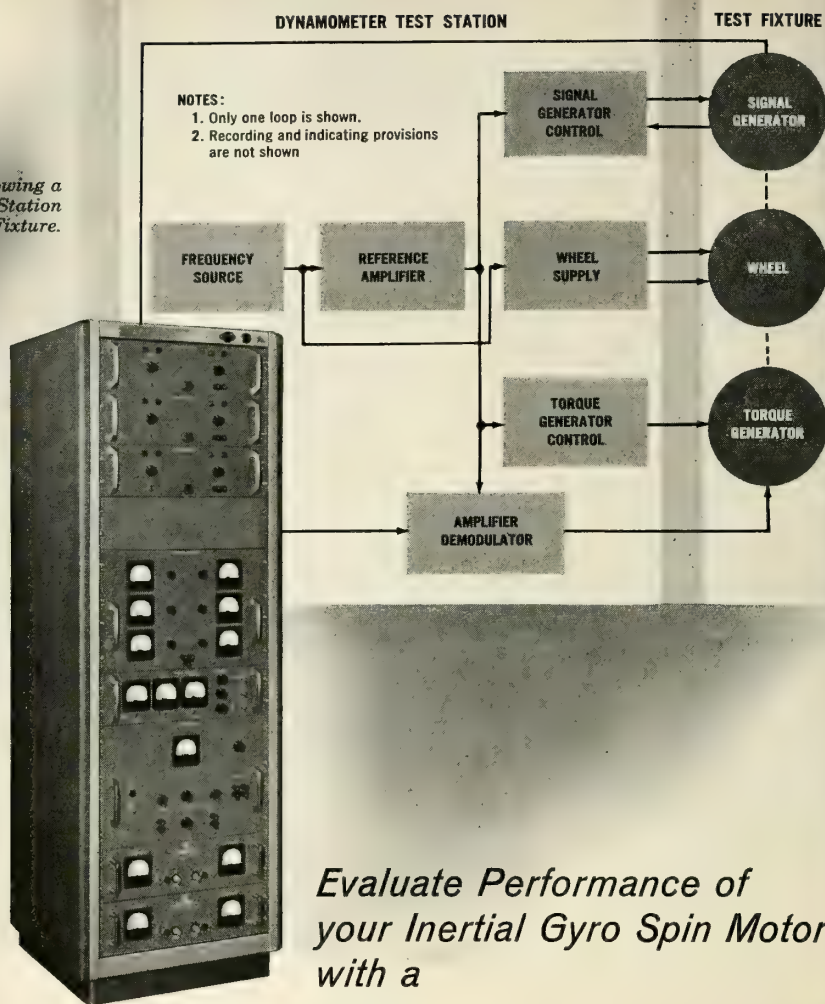
1-4

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# Technical Countdown

## PROPULSION

### High-Temp Nozzle Process Perfected

Engineers at R. E. Darling Co. turned out an experimental nozzle that raised a number of eyebrows at a Navy West Coast testing lab recently. The firm's thermal-pressure molding process fabricates modified asbestos/resin components with densities between 1.94 and 2. Firings with the nozzles at maximum temperatures for 60 seconds resulted in no measurable char or erosion. The process can be used to fabricate complete motor cases, integral aft closures with nozzles or any other moldable configuration. The process controls long fiber alignment and achieves a shingle effect through the nozzle shape. There is no inherent size limitation.

### Accurate Low-Thrust Gaging Possible

Rocketdyne has just delivered a 2.5-ton extrasensitive thrust measurement system to Air Force Systems Command at Wright-Patterson AFB. Designed to measure very accurately the thrust of ion and other electrical propulsion systems, it will be used in a vacuum test chamber. It employs a pendulum suspension to support an engine up to 27 cu. ft. in size and 200 lbs. in weight. Any specified micrometric engine is measurable to 10 lbs., the NAA division says.

### Liquid Propellant Sampler Developed

A dynamic-flow sampling wedge developed for use in Air Force liquid-propellant loading systems offers accuracies within 2.5%. It was designed by Wyle Laboratories for reduction of mainstream contaminant levels over extreme density variation ranges. It also permits sampling of high-pressure flows. Sampling is by a "slice" specimen through all vertical cross-section of a stream to eliminate errors due to settling.

## ADVANCED MATERIALS

### Saturn Bulkhead Electro-formed

Electrical discharge forming may provide single-piece, 30-inch fuel tank bulkheads for Saturn- and Nova-type vehicles. The process, akin to explosive forming, is being researched at NASA's Marshall Space Flight Center. A 7-ft.-diameter unit using a 240,000-joule capacitor bank is being readied for detailed investigations.

### Can Impactors Evaluated

Soft lunar landings may utilize the energy-absorbing qualities inherent in crushing metal cones and cylinders. General Electric scientists will spend the next year studying the phenomena. The GE Missile and Space Vehicle Department experts have found that energy is distributed in a precise manner which causes a pattern of crumpling.

### CBS Studies New Alloy Process

A process for automated production of semiconductor devices using an electron beam shows promise, says CBS Laboratories. Now one year old, the studies are being performed under Army Signal Corps contract. So far, aluminum-silicon junctions have been formed with both electron and ion beams in the fabrication of microjunction diodes. CBS

says tin, silver, and gold also can be alloyed onto silicon surfaces. A planar transistor will be fabricated next.

## ELECTRONICS

### Mosaic Guidance for the Future?

Present-day celestial-supervised navigation systems may be replaced for future interplanetary missions by "mosaic" guidance, says Eugene F. Lally of Jet Propulsion Laboratory. Using multiple detectors, such a system would obviate the need for continuous in-flight reference-axis updating through torquing methods. Reference-axis orientation would be maintained by an onboard computer, thus also eliminating the need for inertial platform, with its inherent drift problems. System accuracy would be comparable to accuracy of known star positions.

### Transit-SNAP Union Praised

Use of higher-powered SNAP (Systems for Nuclear Auxiliary Power) units for operational Transit satellites may now be assured—thanks to current success of the 4.6-lb. test system powering transmitters in *Transit IV-A*. Employing direct conversion of heat generated by spontaneous decay of plutonium-238 fuel, the 5 x 5.5-in. can is providing a continuous output of 2.7 watts, the Atomic Energy Commission says. Built by Martin for AEC, the unit has supplied over 5100 watt-hours of energy to date.

### Sophisticated Guidance in Tiny Missile

*Redeye*, infrared-guided ground-to-air missile for the foot soldier, apparently totes a lot of guidance in a small package. Reportedly, the 4.3-ft., 20-lb. missile can not only chase and hit a strafing jet fighter, but also, when fired laterally, lead an aircraft sufficiently to effect a collision course. Also, a new control approach is used, employing two opposing steering fins in the forward section, says its developer, General Dynamics/Pomona. Canted at a 15-degree angle, fins snap in and out as missile revolves. Amount of turn correction is determined by time of extension.

## SUPPORT EQUIPMENT

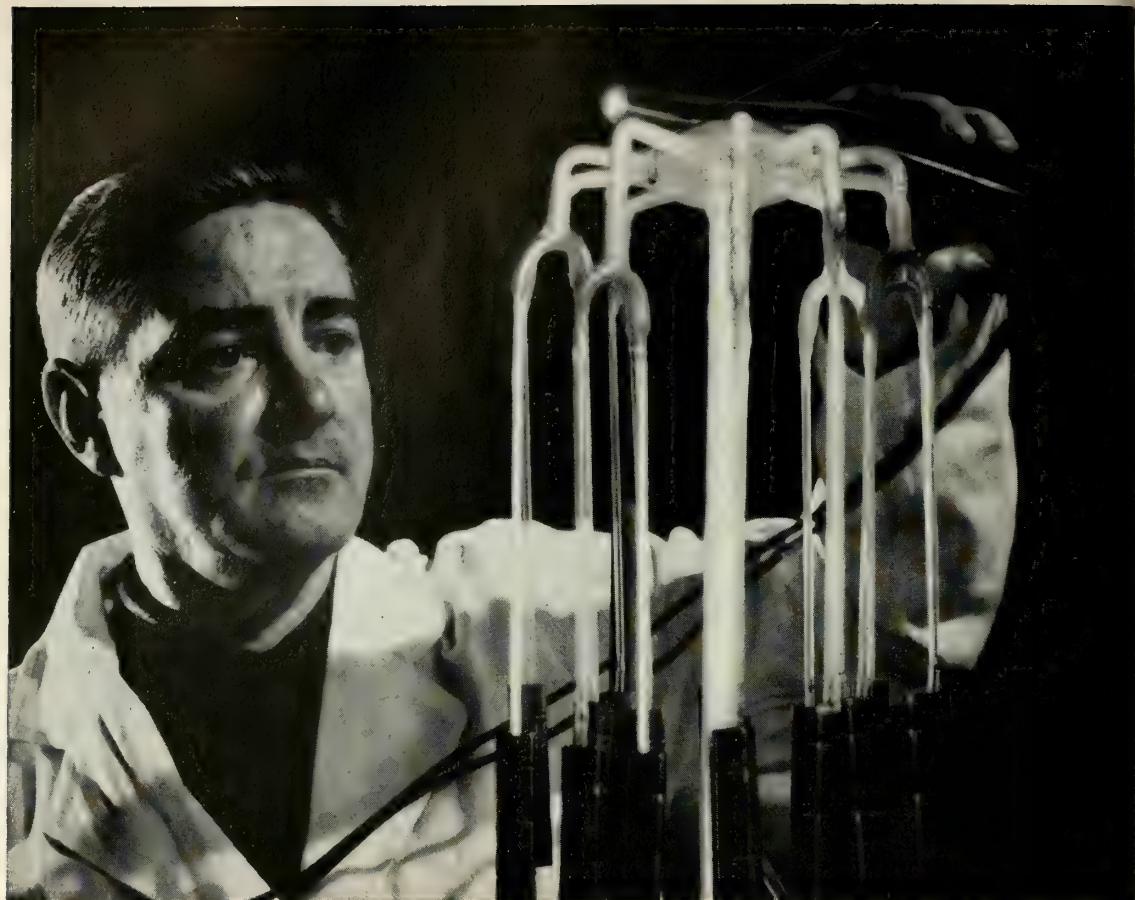
### ATLAS May Surpass STRETCH

An International Business Machines report indicating that its vaunted super computer, STRETCH, has failed to meet cost and performance expectations leaves the field wide open. Only existing comparable system (size and speed) is the Ferranti-produced Atlas—priced about \$6-8.5 million—designed by Manchester University. The IBM system originally was expected to cost around \$13 million, but price soared out of reach during development.

### Data Transmission Advanced

A method for transmitting data over regular land lines at rates up to 15,000 words/minute has been described by General Dynamics/Electronics in Rochester, N.Y. A new phase-modulation technique, called DEFT (Dynamic Error-Free Transmission), is used wherein alphanumeric characters are coded into phase relationships among tones which are transmitted simultaneously. Developers say the system is virtually error-proof and jam-proof.





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(Continued from page 33)

en. This signal, at a frequency between 200 and 2300 mc, is coupled to a wide-band preselector and a narrow-band reselector through a power divider.

The wide-band preselector selects a 4-kc spectrum which is fed to the frequency counter and spectrum analyzer for evaluation of frequency accuracy and deviation. The narrow-band reselector, with a bandwidth of 800 kc, selects only the desired signal spectrum. The selected signal is then coupled to another crystal detector for power monitoring and to a superheterodyne receiver where the video signal is extracted.

The video signal is then fed to a high-speed magnetic tape, where it is stored for later and thorough evaluation. The video signal is coupled also to a heterodyne discriminator, where the PAM is extracted. The PAM signal is routed to the PAM console, where channel separation and monitoring is performed.

The PAM console accepts PAM pulse-train signals from the specimen through the telemetry console and demultiplexes them for measurement. Operation of this console is controlled by a programmer which is part of the console.

The console is a visual/digital display and simultaneously records the measurement results of the channel selected by the programmer on punched-paper tape and on a decimal printer. This operation is performed sequentially for each channel selected by the programmer.

The PAM console also continuously monitors 11 manually preselected channels simultaneously. Each output of 10 of these channels is displayed on an individual d-c voltmeter. The remaining channel monitors the r-f data link PAM signal which is routed to the telemetry console.

The only external commands required by the PAM console are those for "start" and "stop." These commands originate either from the programmer console or from an associated remote-control unit.

A portable unit containing a receiver is used to further enhance the reliability of data acquisition from the payload by providing an alternate channel for the reception of telemetered data.

• **Power distribution**—The power distribution console accepts two feeders from commercial power lines: 208/120 volt a-c, 3-phase, 60-cycle, 4-wire, wye connected. Each feeder will be capable of transmitting a maximum of 100 amperes to the console. Each phase will be

monitored for voltage and current.

Power is routed to a circuit breaker panel and then to the running-time meter panel. The accumulative running-time meters monitor the on-time of the 12-30 ampere, 3-phase power lines. The power is then distributed to the test consoles and to a low-speed data and plotting system. Metering and controls are provided to monitor and control power to the consoles and the 120-v a-c single-phase outlets. ❖

## Mariner GSE

(Continued from page 37)

shaker will first check the systems at 40 cycles and high amplitude along the three axes, then repeat tests on a 28,000-lb. dynamic shaker at higher frequencies.

During Phase 8 a unique test stand, designed to check operation of extendible arms and booms in a minimum-gravity environment, will be used for the first time. These mechanisms are designed for zero-gravity operation; their operating force is just enough to overcome friction at hinge points and joints. Therefore, the test stand has been designed along the lines of a large welding positioner which can orient *Mariner* to a position negating the effect of gravity on a particular arm or boom under test.

By now the *Mariner* spacecraft is almost ready for delivery. Therefore, Phase 9 is a dummy run in which the spacecraft will be held vertically on an adapter simulating the mating structure of *Centaur*. Electrical access will be confined to the umbilical cable and the telemetry link. JPL technicians will conduct a standard countdown to check both the countdown and adequacy of the equipment. The squibs will be fired one time during the dummy run.

A Compatibility Check (Phase 10) will be made at General Dynamics' Sycamore Canyon facility by setting the *Mariner* on a dummy *Centaur*. All the items will be checked—right down to the firing switch. Here propellants and pressurization gases will be loaded for compatibility checks that were too hazardous for the JPL facilities.

• **After delivery**—Phase 11 starts after *Mariner* is delivered to Cape Canaveral. JPL personnel will run through a systems test sequence again, closely repeating the last systems exercise.

The last of the test series using *Mariner* GSE—Phase 12—is called J-FAC, Joint Flight Acceptance Component Testing. This is the final systems test before the *Mariner* vehicle is mated to the operational *Centaur* on the launch stand.

Two complete sets of GSE check-

out equipment will be assembled. One will be maintained at JPL's Pasadena, Calif. facility; the other at Cape Canaveral for launch operations. Estimated cost of *Mariner* GSE is currently set at about one-fourth the vehicle cost. ❖

## Azimuth Alignment

(Continued from page 24)

tional problems—the first of which is the weight of the vehicle. The dry weight of the vehicle is in the order of millions of pounds, and after the fuel is loaded, the vehicle weighs in the order of tens of millions of pounds.

The vehicle gantry is also of tremendous weight and, when the gantry is moved away from the launch area, the earth actually settles. As the fuel is loaded aboard the vehicle, depending on the underlying formation, bending, tipping or other motions can occur.

Cryogenic propellants actually shorten the missile in length as the cold liquid is loaded aboard. And the amount of shortening or twisting is not predictable.

Twist and torsion of this nature can cause the prism located on the platform to become vignetted by the window. Of course, it is really not important what gyrations the vehicle undergoes as long as the platform reference prism during the alignment remains in the collimated beam.

However, to diminish the chances of losing the azimuth reference signal, it is possible to either increase the aperture of the reflector prism or increase the aperture of the theodolite which determines the cross sectional area of the collimated beam of light.

Either or both of these precautions will increase the amount of permissible lateral displacement of the theodolite or the vehicle without losing azimuth transfer capabilities. A third way of increasing alignment capability is to translate the entire theodolite laterally in accordance with vehicle sway by the use of an automatic tracking device.

However, if the vehicle perturbations are extreme—and again it is impossible to predict just what these motions will be—the collimated beam of light may be completely vignetted by the window in the vehicle. This possibility is illustrated in Fig. 2. The vehicle shown is the moving object; if the window moves a matter of a few degrees in any direction it may pass out of the line of sight and obstruct the collimated beam of light. When a theodolite is located at a distance of 500 to 1000 feet away from the vehicle, the line of sight from the theodolite to the platform prism is easily vignetted.

• **Future developments**—Methods of azimuth alignment for deep space



probes in the future might employ a combination of gyro-compassing and star tracking. Gyro-compassing might be used as a coarse azimuth alignment previous to vehicle launch. The star tracker would then be used as a fine alignment sometime after launch. \*\*

## Moon Launching

(Continued from page 35)

enough indicators on board to evaluate critical systems operation and enough reliability in the design, construction and initial checkout to preclude any other checks.

The decision as to what may be the possible malfunctions, what man would be able to repair in the allowed

time, how much equipment could be carried to make these repairs must all be compromised with respect to risk, cost, time, space and booster capabilities. The result of this study will define additional items that may be classed as ground support equipment.

The capability to launch from the moon will first be a function of a successful landing within the design limits of the vehicle. The ability of on-board checkout equipment to satisfactorily give the status of the vehicle will be proved by the series of checks accomplished during the flight from the earth. The successful accomplishment of this portion of the flight will in itself imply reliability in all these systems with the exception of the lunar takeoff engine, and its succeeding satisfactory operation

will give reason to expect high reliability in operation of the lunar takeoff engine.

The use of present inputs to the guidance system for lunar launch reduces the complications of the launching problem to the capabilities of the human crew.

The two highly contrasted operations in the earth-launching of lunar vehicles—with its expenditure of time, men, and machines in large quantities—and the unobserved, noiseless, uncomplicated launch of the lunar launch certainly appear realistic. However, the added complications of the earth launch are backed up by a great deal of ground support for everybody's safety. The simplicity of the lunar launch has its only safety in its built-in reliability resulting from a good design, good operating procedures—and a touch of luck. \*\*

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## Space GSE

(Continued from page 19)

volatile cryogenic fuels.

The blockhouse, although not located close to the launch pad, will have to be hardened to a degree unknown in present launch control complexes. There is no present facility that is capable of sustaining a direct hit by a malfunctioning missile. However, with a booster the size of *Nova*, it may be necessary to provide such a capability by constructing part of the blockhouse underground and hardening that portion above ground.

The launch pad for a *Nova* vehicle—located some 30 to 50 feet off the ground—must not only sustain a blast eight times that of the present *Saturn* but also be capable of being completely reconditioned and ready to accept another missile a week after the initial launch.

In addition to the facilities directly associated with the vehicle launch and control, a complex of industrial and biomedical facilities will be required to support the *Apollo* mission. All of these buildings—as indicated in the accompanying map—will have to withstand noise levels approaching that producing structural damage.

This discussion has centered around the launch facilities required for *Saturn C-3* or *Nova* vehicle. Since some of the decisions relative to the launch vehicle have yet to be made, the basic parameters outlined may change. But whether the basic vehicle is solid or liquid or whether the lunar flight is direct or employs orbital rendezvous techniques, one basic truth will not change: the facilities required to put a man on the moon will far exceed both in size and complexity any that have yet been devised.

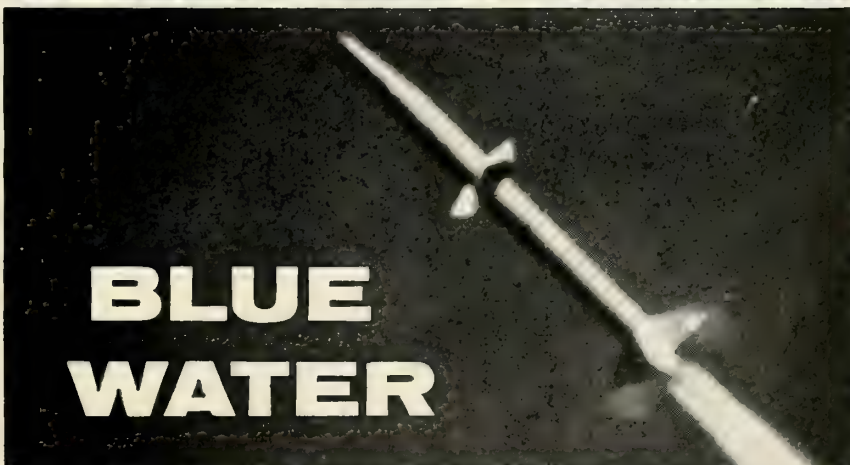
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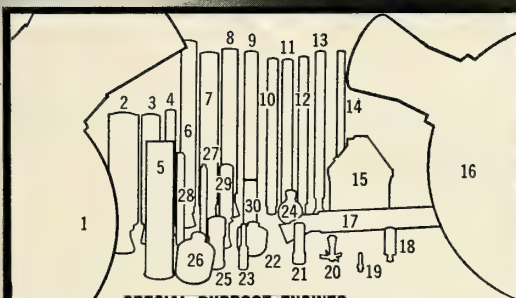
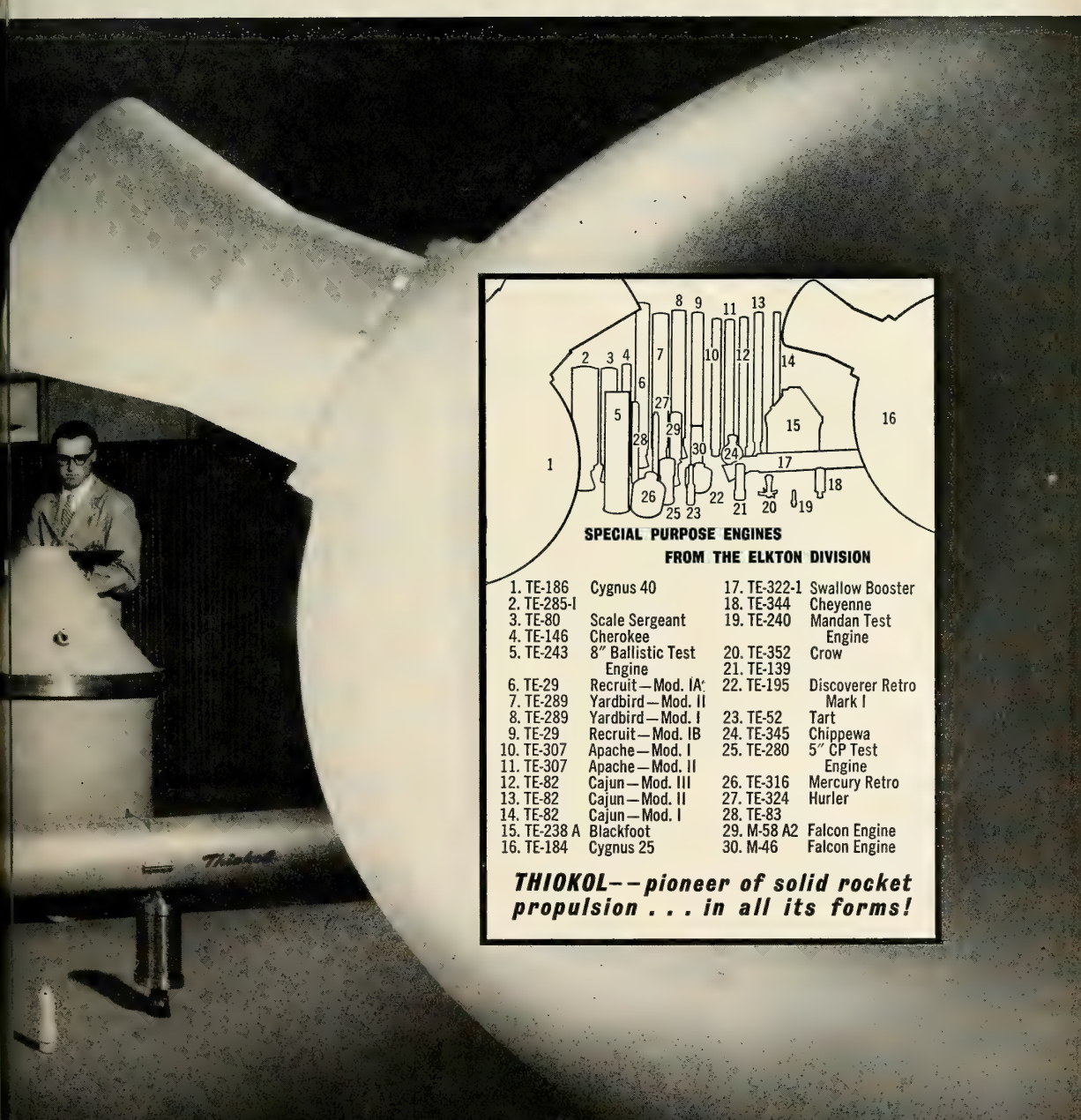


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# science of rocket propulsion

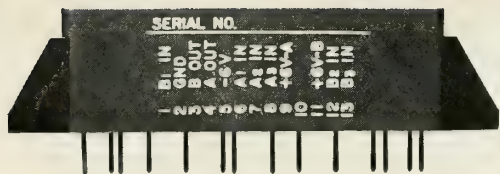


**SPECIAL PURPOSE ENGINES  
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- |              |                   |              |                  |
|--------------|-------------------|--------------|------------------|
| 1. TE-186    | Cygnus 40         | 17. TE-322-1 | Swallow Booster  |
| 2. TE-285-I  |                   | 18. TE-344   | Cheyenne         |
| 3. TE-80     | Scale Sergeant    | 19. TE-240   | Mandan Test      |
| 4. TE-146    | Cherokee          |              | Engine           |
| 5. TE-243    | 8" Ballistic Test | 20. TE-352   | Crow             |
|              | Engine            | 21. TE-139   |                  |
| 6. TE-29     | Recruit—Mod. IA   | 22. TE-195   | Discoverer Retro |
| 7. TE-289    | Yardbird—Mod. II  |              | Mark I           |
| 8. TE-289    | Yardbird—Mod. I   | 23. TE-52    | Tart             |
| 9. TE-29     | Recruit—Mod. IB   | 24. TE-345   | Chippewa         |
| 10. TE-307   | Apache—Mod. I     | 25. TE-280   | 5" CP Test       |
| 11. TE-307   | Apache—Mod. II    |              | Engine           |
| 12. TE-82    | Cajun—Mod. III    | 26. TE-316   | Mercury Retro    |
| 13. TE-82    | Cajun—Mod. II     | 27. TE-324   | Hurler           |
| 14. TE-82    | Cajun—Mod. I      | 28. TE-83    |                  |
| 15. TE-238 A | Blackfoot         | 29. M-58 A2  | Falcon Engine    |
| 16. TE-184   | Cygnus 25         | 30. M-46     | Falcon Engine    |

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In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

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## names in the news

**Dr. William J. Perry and Frank E. Butterfield:** Appointed director and chief engineer, respectively, Electronic Defense Laboratories, Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corp. Other appointments are: **W. Herbert Lamb**, vice president of newly formed Microwave Device Div., Mountain View, Calif.; **Merle W. Kremer**, vice president, and **Daniel Echo**, product manager-display devices, Electronic Tube Div.; **Maxwell C. Scott**, manager-conversion and manufacturing for Mountain View Operations; **Larue D. Rexroat**, manager-government relations-Western Region, and **Jerome J. Weaver**, district marketing manager-Southeastern Region, Sylvania Electronic Systems; **John B. Donner**, manager-microwave and antenna laboratory, Waltham Laboratories; **Joseph E. Sheehan**, manager-market research and planning, and **Walter W. Smock**, product manager-militarized computers, Data Systems Operations.

**George A. Banino:** Elected vice president and general manager, Communications System Dept., ITT-Kellogg, a division of International Telephone and Telegraph Corp., Chicago.

**Max J. Schuller:** Promoted to manager, Semiconductor Device Development Section, CBS Laboratories, Stamford, Conn., a division of Columbia Broadcasting System, Inc.

**Howard A. Zeimer:** Joins Marks Polarized Corp., Whitestone, N.Y., as director of Military Liaison and Public Relations.

**Ernest A. Reddle:** Named manager of newly-formed Western Division, Navigation Computer Corp., Los Angeles. Before joining NAVCOR, Reddle was research engineer on the instrumentation of the Ranger lunar probe, Jet Propulsion Laboratory.

**J. V. Naish:** Former president of Convair and senior vice president of General Dynamics Corp., elected a director of McDonnell Aircraft, St. Louis.

**Vernon H. Kiebler:** Named electronic programs manager; **Stuart L. Dunkle**, Western marketing activities manager; and **Ray T. Prout**, Eastern marketing activities manager for Elgin National Watch Co.'s Industrial Group, as part of the company's expansion program into missile/space business. Prout will be in charge of the newly opened Washington, D.C., electronic and missiles office; Dunkle will supervise marketing activities at the Burbank and Chatsworth, Calif., facilities, and Kiebler will have headquarters in Elgin, Ill.

**Robert J. Segal:** Appointed manager, Design Engineering, for high-speed message-switching centers being instrumented by the Radio Corporation of America in a nationwide U.S. Air Force communications system (ComLogNet).

## ENGINEERS & SCIENTISTS in the fields of space vehicle power and propulsion

The Propulsion and Power Systems Department of the Aerospace Vehicles Laboratory has several unusually interesting openings for engineers and scientists who are interested in the fields of space vehicle power and propulsion. The openings are at all levels of experience—from recent graduates to the senior staff level. Most of the positions will involve design and analysis of power and propulsion systems for satellite and space probe application. Specifically, some of the areas of specialization are:

### 1 SPACE POWER SYSTEMS

The positions will involve analysis and development of such energy sources as: photo voltaic, thermionic, thermoelectric, battery and advanced energy storage systems.

### 2 SPACE PROPULSION SYSTEMS

The positions will involve the preliminary and conceptual design and comparative analysis of all types of chemical and electric propulsion systems.

### 3 PROGRAM MANAGEMENT

The positions will be associated with the development of solid and liquid propellant rocket engines. Advanced degrees are preferred and considerable experience in the field will be required.

If you are interested and believe that you can contribute, please mail your resume to:

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**Delmar M. Morris:** Deputy director for administration at NASA's George C. Marshall Space Flight Center, died in Huntsville of a heart attack. Morris, who was 48, joined NASA in 1960. He had previously served with the Atomic Energy Commission.

**Gordon R. Miller:** Named manager, Avionics Section, U.S. Science Corp., Los Angeles. Prior to joining U.S. Science, Miller was manager of marketing programs and divisional chief engineer in charge of new product development for Whittaker Gyro Div., Telecomputing Corp.

**James Hollis:** President of Rixon Electronics, and **Gordon Frederick,** of Thompson Ramo Wooldridge, elected directors of White Electromagnetics, Inc. (formerly Don White Associates), Bethesda, Md.

**Dr. Scott C. Daubin:** Appointed head of marine sciences section, Sea Operations Dept., General Motors Defense Systems Div., Santa Barbara, Calif. Dr. Daubin recently resigned from the U.S. Navy, in which he held the rank of Commander.

**F. M. Fulton:** Named director of new Applied Science Division, Hycon Mfg. Co., Santa Paula, Calif. Fulton formerly was head of the Propulsion Development Dept. and assistant technical director for development of the Naval Ordnance Test Station, China Lake, Calif. He also was coordinator of astronautics for the station, and a member of the long-range Fleet Ballistic Missile Research Committee, Washington, D.C.

**Robert F. Fallon:** Appointed manager of Industrial Relations for Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif.

**Louis B. Young:** Named general manager of Bendix Corp.'s Systems Div., Detroit, succeeding **Roy J. Sandstrom,** recently promoted to the Mishawaka Div. of Indiana.

**Will Mitchell, Jr.:** With Allis-Chalmers Mfg. Co., Milwaukee, since 1947, appointed director, Research Division.

**Harold Niles:** Appointed government relations manager in charge of the Washington, D.C., office of Ford Instrument Co. Division of Sperry Rand Corp.

**Dr. Chester H. McCall, Jr., and D. Alan Kendall:** Promoted to research directors, Statistics, and Program Control, respectively, for Booz, Allen Applied Research, Inc., Bethesda, Md.

**Charles W. Brunstetter:** Promoted to general manager, Ipsen Industries, Inc. Brunstetter was responsible for the development of the Refractory Metals Division of Ipsen. He was formerly vice president of Astrometals Corp.

**Jay M. Bedrick:** Former chief engineer of Integron, Inc., named manager of electromechanical research and development dept. of Minneapolis-Honeywell's Boston Division.

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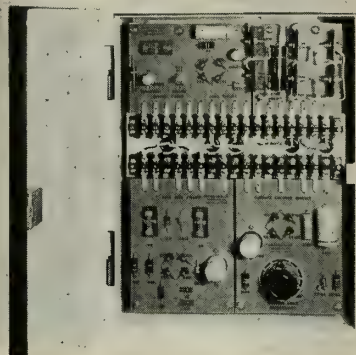


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## products and processes



### Variable Power System

Hevi-Duty Electric Co. is marketing a proportional power magnetic amplifier for precise electrical control application.

Coupled with a standard saturable core reactor, the amplifier is the electrical equivalent of an equal percentage change in process power. It takes signals from any control system with a 0-5 milliamper output, the process voltage and current, and combines these in a magnetic amplifier whose output is fed to the control winding of a standard saturable reactor.

This combination of signals and the high power gain of the D 77312 Magnetic Amplifier changes the typical characteristic curve of the saturable reactor to a proportional power relationship.

To simplify maintenance, the amplifier is constructed as five separately removable circuit panels installed in a heavy-gauge steel box with provisions for either flush or surface mounting. Any one of the sections can be removed independently of the others without changing or disconnecting any of the normal wiring to the device.

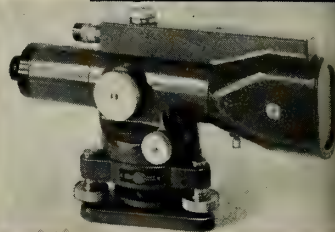
Circle No. 225 on Subscriber Service Card

### Extension Swivel Fitting

Dumont Engineering Co. has developed a swivel fitting for fluid systems capable of accepting extension and contraction of its rotating end. This feature makes it possible for two sections of a fluid line system to be connected and then drawn together and sealed within an enclosure. The unit permits the fluid lines in each section of a missile to be connected by a rigid metal fitting. The connections are made when the fitting is fully extended. The unit is then con-

new  
generation

## Autoset Optical Level



### Automatically Maintains Level Line of Sight

The new Autoset Level is based on optical compensator, suspended free from all friction. It assures repetitive setting better than 1 second of arc. Autoset optical displacement micrometer reads height directly to .001" over a full 1/2" range.

### Auto-Collimating Eyepiece

With this accessory the Autoset becomes an automatically horizontal collimator and auto-collimator.

For complete details, ask for Catalog No. 56-121

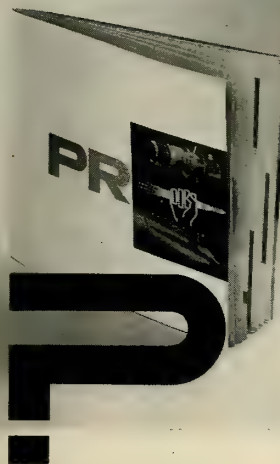
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tracted, permitting the two sections of the missile body to be brought together and sealed in the final assembly. The first units were made in the 1/4-in. tube size. The entire assembly is only 10 in. long and 3/4 in. in diameter. It achieves a full 6-in. extension without leakage, under high- or low-pressure service. The extension end of the fitting may also be rotated a full 360°.

Circle No. 226 on Subscriber Service Card

## Miniature Tape Recorder

A multi-channel, miniature magnetic tape recorder, capable of operating through extreme environmental conditions—including up to 1000 g shock—is available from Borg-Warner Controls, a Division of Borg-Warner Corp. Designed for recording flight test information on advanced missiles and space



vehicles, the recorder, MR-21, is small and lightweight and can record up to 14 channels of data simultaneously on 1-in. magnetic tape. Total tape capacity is 69 ft. Among the important features of the MR-21 is a unique recording method which allows operation with either a-c or d-c input signals. Power requirements are extremely low, and wow and flutter are less than 1% under static conditions.

Circle No. 227 on Subscriber Service Card

## Magnetic Multiplier

A miniature magnetic multiplier for converting the product of two electrical inputs into a single proportional a-c output is available from Transmagnetics, Inc. The device, designated Model 300AX, features a 1% full-scale multiplier accuracy. A d-c input current range of 0 to  $\pm 100$  ua, plus an a-c input range of 0 to 2.3 volts, phase reversing, generates a phase sensitive a-c output from 0 to 1.2 volts—being directly proportional to the product of the inputs. Although these ratings are at

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# D-C POWER

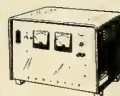
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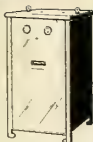
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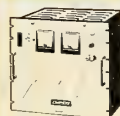
TRANSISTOR-  
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## ...products and processes

400 cps, the Model 300AX is operable from 300 to 100 cps over a temperature range of  $-55^{\circ}$  to  $85^{\circ}\text{C}$ . Two separate d-c inputs permit algebraic summation operations. All inputs and outputs are completely isolated.

Circle No. 228 on Subscriber Service Card



### Miniature Floated Gyro

A miniature two-degree-of-freedom floated gyro of extreme inertial precision for long-duration space guidance systems is being produced by Arma Division, American Bosch Arma Corp. Designated the G8 gyro, it is only one-quarter the weight and one fifth the volume of the current Arma gyro in the *Atlas* inertial guidance system. The G8 contains an inner gimbal which is a sealed floated beryllium sphere contain-

ing the wheel assembly. Two degrees of freedom are provided by interposing a floated solid beryllium ring, having no moving parts, between the inner gimbal and the external housing of the gyro. Because of its ability to stabilize about two axes, only two G8 gyros are required for an inertial platform.

Circle No. 229 on Subscriber Service Card

### Miniature D-C Amplifier

A highly stable solid-state, plug-in d-c amplifier has been developed by Quan-Tech Laboratories, Inc. The unit provides a gain of 10 and frequency response extends from d-c to 5% down at 100 kc. Stability of the amplifier approaches that of a chopper-stabilized unit, with typical drift being 3 mv up to  $120^{\circ}\text{F}$ , referred to the input. At constant ambient temperature, drift is no more than  $\pm 250$  uv.

Circle No. 230 on Subscriber Service Card

### Time Delay Relay

Instantaneous recycling and multiple-contact time delay relays are available from Branson Corp. in a container that will directly replace older standard thermal delay relays. The MTRH4 time



delay relay, with an operating delay range of 1 to 90 seconds and an accuracy of  $\pm 10\%$ , 0.5-sec. minimum features multiple output contacts. The MTRH8 is a voltage-compensated, instantly recycleable time delay relay with an operating range of 15 to 300 sec.

Circle No. 231 on Subscriber Service Card

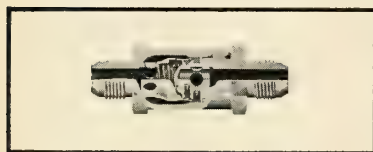
### Tiny Transistor Chopper

A miniature transistor chopper with its own self-contained drive transformer is available from Cambridge Division of Airpax Electronics, Inc. The chopper, Type 6022-3, is designed for use in printed circuit applications. The unit

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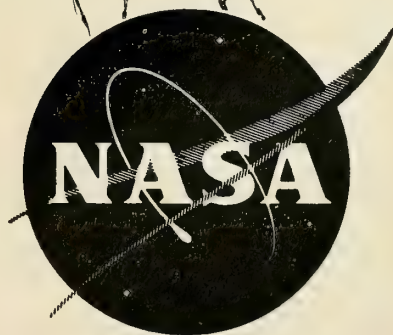
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Missiles and Rockets

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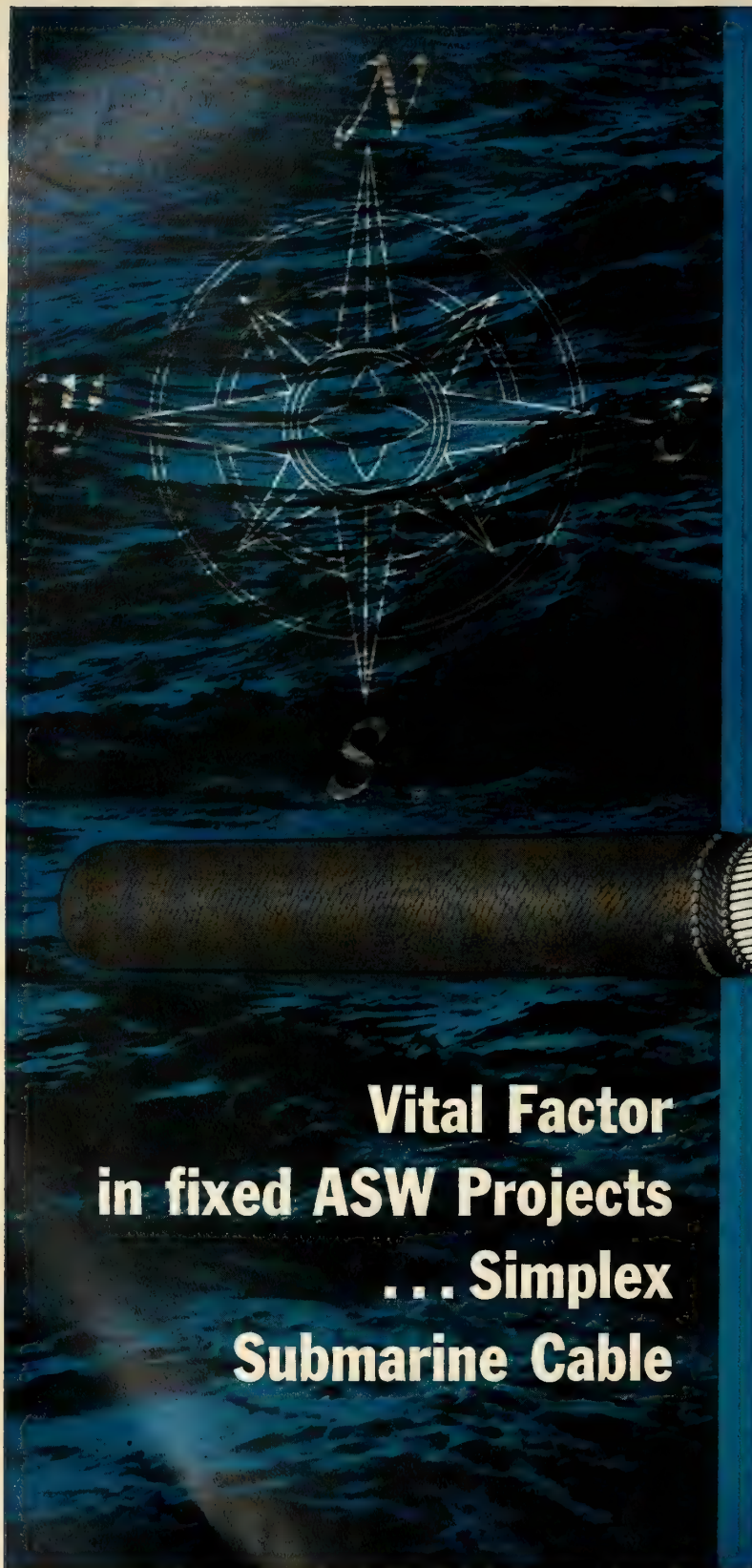
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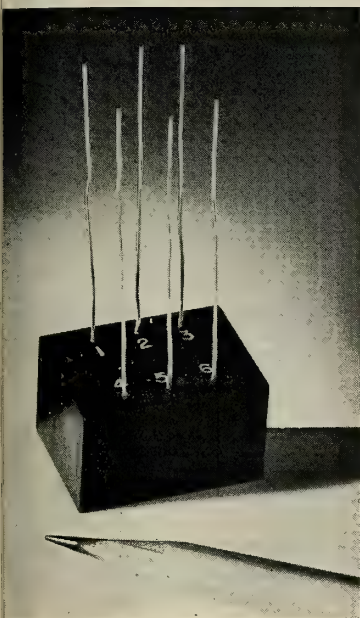
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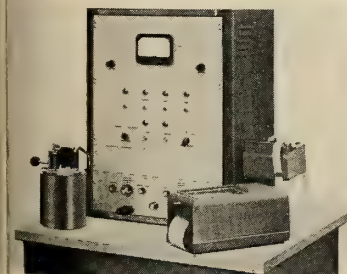


interrupt electrical current at very precise rates, and with minimum noise and offset. For example, weak d-c signals telemetered from great distances in space can be converted to pulses, and then amplified for accurate information read-out." Used as a series shunt modulator, a typical printed circuit application, the Airpax 6022-3 maintains the noise level at 1 millivolt or less.

Card No. 232 on Subscriber Service Card

### Non-Linear Pot Tester

A non-linear potentiometer conformity tester with tape-programmed junction control plus display and chart readout is available from Jonathan Electronics Corp. Operating on principles similar to those employed by programmed automatic missile checkout equipment, the system electronically compares actual potentiometer voltage output with theoretical values at various incremental shaft positions. The automatic test system consists of four functional elements: an angular index head, an



eight-channel punched tape reader, a control console and a dual-channel oscillograph.

Circle No. 233 on Subscriber Service Card

### Moving Temperature Control

Continuous temperature measurement and temperature control of inaccessible, fragile or rapidly moving objects, at temperatures as low as 300°F, is now possible with the Pyrotel Model PY45, manufactured by Mason Instru-

ment Co. The incorporation of a synchronous chopper assures stability, sensitivity and rapid response times of 20 milliseconds, thus enabling accurate, repeatable temperature readings on targets such as wire travelling at 5000 ft. per minute. The precision-built detector head permits temperature reading of targets as small as 0.0003 wire or as large as "the side of a barn."

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### Ceramic Base Material

A ceramic material, developed especially for use as a base for carbon-deposited and metal-film resistors, is



The "Big Four" land-based strategic surface-to-surface U.S. missiles—Douglas Thor, Convair Atlas, Martin Titan II, and Boeing Minuteman—are backed by multiple production ground support air conditioning units engineered and manufactured by the C. G. Hokanson Company, Inc. This "grand slam" award of all four competitive production contracts is the best evidence that the name Hokanson is a guarantee of design excellence, performance, and reliability in ground support air conditioning.

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## ...products and processes

available from Centralab, The Electronics Div. of Globe-Union Inc. Designated as Centralab Body 702, this material can be supplied in a wide range of diameters and lengths.

Circle No. 235 on Subscriber Service Card

### Vacuum Thermocouples

A complete range of miniature vacuum thermocouples (Vacuo Junctions), including an entirely new design, are available from Barker Sales Co. Manufactured by Best Electric Co., the regular range of the couples includes

"Standard" types for low and audio frequencies—with heater ratings from 1.25 milliamps and up—and ultra-high-frequency types for r-f applications from 5-milliamp heater ratings. The UHF types have straight-through heaters and low intercapacity. Unmounted, open-wire thermocouples are also available for meter manufacturers.

Circle No. 236 on Subscriber Service Card

### Personal Radiation Monitor

Nuclear Materials and Equipment Corp. (NUMEC) is marketing a mini-



ature personal radiation monitor. The NUMEC PRM weighs only 3.5 oz. About the size of a fountain pen, the PRM's components are contained in an easily decontaminated stainless steel casing. Worn in the breast pocket of the user, it provides simultaneous chirping sounds and light flashes at frequency intervals in proportion to the amount of gamma radiation present in an area. The distinctive chirping sound is near the point of maximum sensitivity on the hearing curve, 2800 cycles per second.

Circle No. 237 on Subscriber Service Card

### Micro-Micro Ammeter

Radiation Technology, Inc. has announced a low-drift micro-micro ammeter designated the Model R660. A highly stable, temperature-compensated transistorized amplifier with an electrometer tube input is arranged so as to produce almost 100% feedback. This

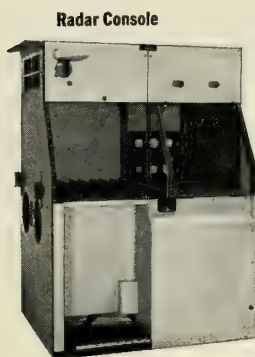


results in a low input impedance and reduces drift due to changing electrometer tube characteristics. The instrument has twenty ranges from  $3 \times 10^{-3}$  to  $1 \times 10^{-12}$  amperes full scale. Drift is less than  $\pm 2\%$  of full scale per week after an initial warm-up of less than 10 min.

Circle No. 238 on Subscriber Service Card

### Digital Transmission

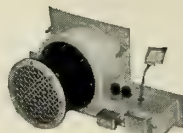
A digital data transmission system, CTDS 2400, has been developed by Hallicrafters to allow data acquisition and processing systems to communicate over low-cost, universally available commercial-quality voice communication channels. High-speed transmission of digital data, with maximum reliability, can be accomplished without ex-



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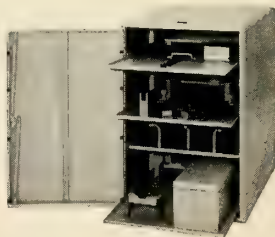


Radar Reflector



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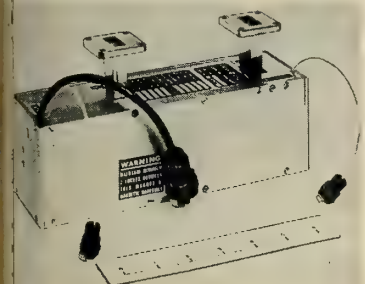
Circle No. 41 on Subscriber Service Card

oing many costly equalization networks. The Hallicrafters CTDS 2400 system—consisting basically of a transmitter and a receiver—converts binary pulses to an audio frequency signal which can be transmitted and demodulated in the receiver to yield the original signal with a maximum error possibility of only one bit in a hundred thousand. The system transmits at the preferred military field data rate of 100 bits per second.

Circle No. 239 on Subscriber Service Card

## Traveling—Wave Amplifier

A low-noise, metal-ceramic traveling-wave tube amplifier for use in the 100-8500 megacycle frequency range available from the Power Tube Dept. of the General Electric Co. The tube, designated Z-3093, has a maximum noise figure of less than 7.5 db and a



modulated power output of five milliwatts across the entire band. Gain is at least 25 db. The Z-3093 is supplied as a complete package, including the permanent magnet focusing assembly and waveguide input and output r-f connectors.

Circle No. 240 on Subscriber Service Card

## Component Container

Flexi-pak, a storage container offering a new approach to the packaging problem, is being marketed by Royal Jet, a division of Royal Industries, Inc. Fabricated from aluminum, the lightweight product couples variety and simplicity of design by using basic engineering components for a number of package



specifications. This feature, called modular construction, permits great flexibility in meeting demands for package size, while the repeated use of basic design components reduces engineering and tooling costs. The container is designed to absorb a significant amount of shock. Flexi-pak's added protection permits a less complex shock-mount support system for the packaged unit, and formed-skin protrusions on the shell provide bumpers which protect accessories and instruments mounted or housed on the outer shell. Providing the advantage of controlled atmosphere storage, the flexible container is

equipped with free-breathing valves, an indicator for internal humidity and sealing nested between specially designed aluminum extrusions.

Circle No. 241 on Subscriber Service Card

## Three-Port Circulator

A high-power broadband three-port circulator is being marketed by Kearsott Microwave Division, General Precision, Inc. The circulator may be converted into a microwave switch by replacing the permanent magnet with an electromagnet. Models with power-handling capabilities of 50 kw or more are avail-



The first American Astronaut in Space will rely on a continuous supply of oxygen metered through intricate valving which has been designed by Garrett Corporation, AiResearch Manufacturing Division, engineers with the technical assistance of Stillman Rubber Company experts.

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For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, California. Phone: CYpress 4-8124.



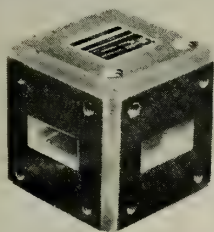
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... on request. Outstanding features of the new three-port circulator are: frequency range; 8.0-10.5 kmc; isolation: 0 db min.; insertion loss: 0.4 db max.; swr: 1.20 max.; power: 25 kw peak, 5 w average; connectors: mate with g/39/u.

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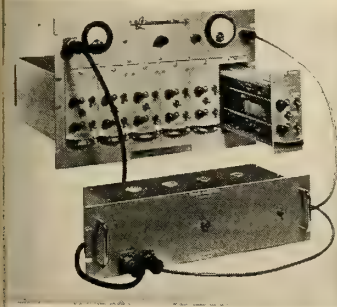
## High-Temp Transducers

A series of ultradyne pressure transducers designed to provide accurate measurements with ambient temperatures as high as 1000°F and to have high resistance to nuclear radiation is being marketed by Consolidated Controls Corp. Available as gauge, absolute and differential pressure measuring devices, transducers of the 411 series provide nominal full-scale output of 200 millivolts with an accuracy of 2½% over the entire temperature range from -65 to 1,000°F. At room temperature, accuracy is 0.5%; over any 250° span, 1%. Units are available with full-scale measurements ranging from 0.6 to 1000 psi.

Circle No. 243 on Subscriber Service Card

## Strain Gage Conditioner

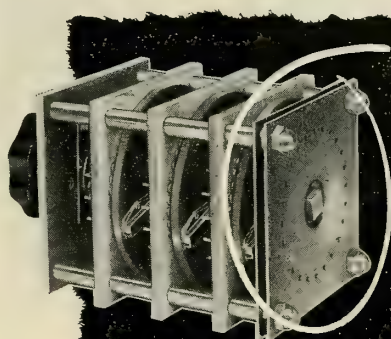
The B & F Instruments, Inc. Model 400 Servomatic Modular Strain Gage and Transducer Input Conditioner accommodates any type of resistance strain gage or transducer. Each module contains its own individual floating



missiles and rockets, September 18, 1961

# NEW FROM Langevin

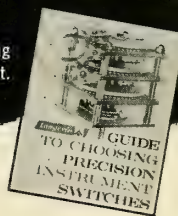
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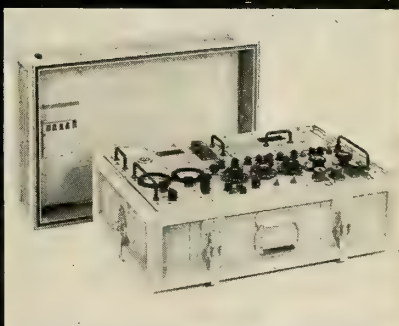
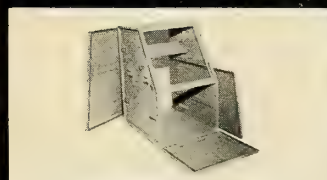
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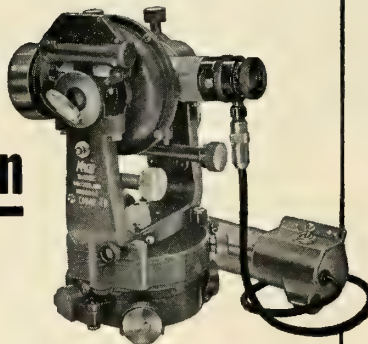
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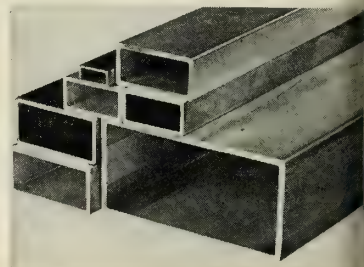
power supply. The necessary sophistication has been added so that the depression of one pushbutton will cause automatic servo balancing and automatic setting of the sensitivity control.

The servomatic system will null to  $\pm 10$  microvolts. A unique manual override is provided for normal manual balancing and voltage selection. The automatic calibration feature is also part of this new conditioner.

Circle No. 244 on Subscriber Service Card

### Waveguide Tubing

Precision grades of coin silver waveguide, in frequencies from 18 kmc to 325 kmc, are in regular production and available from Horton-Angell Co. Special sections, C-band and smaller, to



any dimension and tolerance, can be rapidly produced in a variety of materials including steel, aluminum, brass, copper, invar, and laminated metals.

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### Double Triode

A medium- $\mu$  VHF double triode has been added to the strap-frame subminiature electron-tube line of Sylvania Electric Products Inc. The unit, Type 8103, is designed for use as a cathode follower or RF amplifier-mixer in hybrid systems. Because it has 26.5-v heater and plate operation, the tube requires no special plate or heater supply circuits. The double triode structure enables the tube to replace two or more vacuum or solid-state devices.

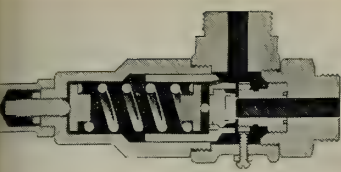
Circle No. 246 on Subscriber Service Card

### Hi-Q Disc Feed-Thru

A disc feed-thru capacitor is available from the Hi-Q Division, Aerovox Corp. Designated type 1107, the completely encapsulated unit employs a ceramic disc as the dielectric. Resonant frequency is higher than 1000 mc. The discoidal construction provides efficient shielding of radiation in the frequencies of UHF and VHF TV bands. The capacitor is available in a capacity range from 5 to 1000 mmf with a 500 d working voltage.

Circle No. 247 on Subscriber Service Card

missiles and rockets, September 18, 1961



**Positive-Seating Valves**

An adjustable, positive-seating relief valve for liquid or gas service to 5000 psi is available from the Combination Pump Valve Co. Combining a resilient, flat-seated nylon disc with guided lift design, the valve maintains a tight, leak-proof seal until the present pressure is exceeded. Problems of leakage caused by spring deflection and galling in metal-to-metal seated valves are completely eliminated.

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**New literature**

**STRAIN GAGE** — "38-G Silicon Semiconductor Strain-Gage Pressure Transducer," a brochure describing the airchild solid-state pressure transducer is available from Fairchild Controls Corp. The brochure contains design and performance data on both the airborne and ruggedized versions of the 3S-G.

Circle No. 200 on Subscriber Service Card

**ELECTRONIC TIMING SET** — Four different applications using digital time signals to coordinate remote equipment in complex instrumentation and data-processing systems are described in a brochure available from Hallicrafters. Examples include: (1) airborne reconnaissance with automatic data logging, (2) ground timing system for test ranges and missile sites, (3) data processing with time compression and expansion features, (4) ground support equipment for performance checkout.

Circle No. 201 on Subscriber Service Card

**MISSILE ALLOYS**—A booklet on high-temperature, high-strength alloys used in the aircraft, aircraft engine, gas turbine, missile and any other applications where corrosion resistance and high strength at elevated temperatures are needed, is available from Allegheny Ludlum Steel Corp. It features a series of steels and alloys, each with its own individual leaflet, together with a 28-page general booklet on high-temperature alloys. While all the materials are treated in the general booklet, each steel alloy is treated in detail in the accompanying individual leaflet. Eleven alloys are treated individually.

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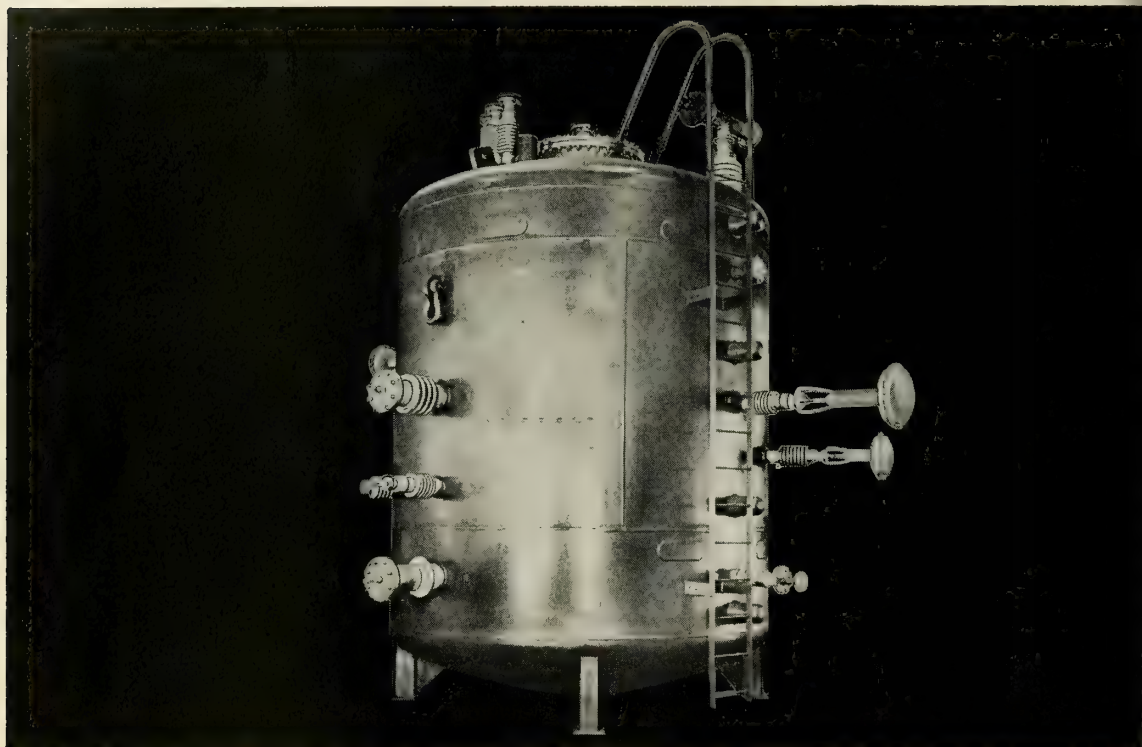
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# Another Unmanned Shot Planned

**NASA says three-orbit flight is needed to test out capsule before putting man in it; astronaut trip unlikely this year**

by Hal Taylor

ANOTHER TRIAL run will be conducted with *Mercury Atlas* before the United States risks putting a man into orbit.

The decision for the second shot—on the heels of last week's successful one-orbit first flight of a *Mercury Atlas* carrying a "robot" crewman—means there is only an outside chance of a U.S. manned orbital flight taking place this year.

Dr. Robert C. Gilruth, Project Mercury head, and NASA Administrator James E. Webb both declared that one more shot is needed before a manned flight attempt. It has not been decided whether the capsule will contain another robot or have a monkey aboard.

With six to eight weeks required between *Mercury* shots, the space agency will be hard-pressed to achieve its goal this year.

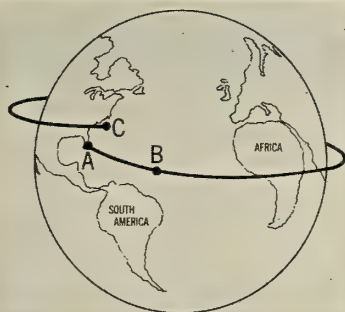
Any long delays because of weather or technical difficulties experienced during earlier *Mercury Redstone* and *Mercury Atlas* shots would push the timetable for manned flight into 1962.

NASA officials hailed the success of the *MA-4* shot and the successful recovery of the capsule by a Navy destroyer. Preliminary information indicated that all systems worked well. The capsule was injected into orbit at an altitude of 100 miles and reached a perigee of 158.6 miles. Top velocity reached during the one-hour-and-49-minute flight was 17,519 miles per hour.

While officials claimed the shot proved that manned flight was possible, they said another unmanned flight was necessary to further test the *Mercury* spacecraft and attempt a three-orbit flight like that planned for the first manned shot.

• **Hatch test vital**—Principal reason for another flight is to test the explosive hatch mechanism which malfunctioned during the suborbital flight of Astronaut Virgil Grissom in *MR-4* July 22.

The capsule used in the *MA-4* flight was not equipped with the explosive hatch. The *MA-4* capsule is an early



*MA-4* took off from Cape (A), orbited at (B). Capsule was picked up at (C).

model. Only *Mercury* spacecrafts from Number 7 onward are equipped with the new hatch.

Officials said the more modern hatch was not used on the *MA-4* flight because "they are not available in large numbers."

The *MA-4* capsule did not have a landing bag to cushion the shock of impact. As a result, the capsule impact was harder than it would be for a manned flight.

Final reason cited by officials is the need to fly an unmanned three-orbit mission so that the capsule, retrorockets, and recovery forces can be checked over the same period that the first American orbiting astronaut will be subjected to space flight.

• **Smooth success**—NASA officials were especially pleased with the performance of the *Atlas* booster and the *Mercury* tracking network. Technical difficulties which plagued earlier *Mercury Atlas* shots were absent in *MA-4* as the big booster lifted cleanly from its pad, developed the desired thrust and injected the *Mercury* capsule into orbit at the planned altitude.

Each station on the Mercury Tracking Network picked up the capsule on schedule and was read "loud and clear" by control centers at Cape Canaveral and Goddard Space Flight Center.

Officials were gratified by the accuracy of the flight. Chutes designed to

slow down the capsule after re-entry into the atmosphere opened only 21 sec. after the planned time, and the impact area south of Bermuda was only 39 miles from the "nominal" landing area.

There was one malfunction which NASA officials said would require further study. The mechanical man simulator in the spacecraft used up an unusual amount of oxygen. It was possible there may have been a leak in the system. Oxygen use of the same volume during a manned flight would force the astronaut to abort after one orbit.

Pressure in the spacecraft during the flight registered a high of only 7½ g, less than has been recorded during the suborbital flights. Other figures released included: weight of spacecraft at launch, 3900 lbs., weight in orbit, 2700 lbs. and weight at impact, 2200 lbs.

• **A minor problem**—One other difficulty cropped up when communications between the capsule and ground stations was lost for a time over the Pacific. This was blamed on the tape recorders in the capsule. It was classed as a minor problem because the astronaut will communicate directly with the ground stations.

There was no visual contact with the capsule as it re-entered the atmosphere and impacted in the Atlantic. It was tracked by radar on the recovery ships, however and a Marine helicopter hovered over it shortly after impact. The capsule remained in the water well over one hour while the recovery ships raced toward it.

NASA said the successful *MA-4* flight proved that:

—The spacecraft can withstand the 2000°F heat of re-entry.

—The modified *Atlas* launch vehicle can release the spacecraft at the precise speed, altitude, and flight-path angle for orbital flight.

—The spacecraft systems can operate on a fully automatic basis for nearly two hours.

—The braking rocket system can bring the craft safely down from orbit.



# First Details of Ranger III's Lunar

**Surviving capsule to use retrorocket to slow speed for hard landing; impact velocity of 108 ft./sec.**

THE BALSA-CUSHIONED *Ranger III* instrument capsule will use its own retrorocket to slow its speed to under 150 miles an hour when it impacts the moon.

NASA has released first details of the spherical capsule, scheduled to be launched early next spring as the first U.S. effort to hard-land instrumentation on the moon.

The 56.3-lb. globe is the only part of the *Ranger III* vehicle which is intended to impact safely. About 20 to 25 miles above the lunar surface, the instrument capsule will be separated from the main craft. Its retrorocket will slow its final closure rate to under 150 miles/hour, and, it is hoped, land its vital physical measurement devices intact.

The rest of the vehicle will continue at roughly 5000 miles an hour and be destroyed when it hits the moon's surface. Among its several experiments, the main craft will employ a low-resolution TV camera to transmit pictures of the lunar surface back to earth as it descends.

The *Ranger* spacecraft is now under development at the Jet Propulsion Laboratory in Pasadena, Calif. The capsule itself is being developed for JPL by Aeronautic Division of the Ford Motor Company in Newport Beach, Calif.

• **Eight to go**—The National Aeronautics and Space Administration says present plans call for launching a total of nine *Ranger* vehicles. The program is a prelude to a manned lunar landing by 1970.

*Ranger I*, launched on Aug. 23, was designed to test hardware and technology in a highly eccentric earth orbit. Its orbit was too low, but its instruments worked satisfactorily.

*Ranger II* will be launched in October on a similar mission to complete Phase 1 of the program. *Ranger III* will be the beginning of Phase 2, and

will be followed by two similar attempts.

• **First capsule details**—The survival sphere now being built by Aeronutronic is a 12-in.-diameter shell containing a seismometer, temperature recorders, supporting electronics, and power supply. The instrument shell is nested within an approximately 6-in.-thick outer shell of balsa wood. Nearly 8 lbs. of flotation liquid separates the inner package from the wood, helping to distribute the structural loads on final impact. Overall package size is 25 inches in diameter.

The liquid also permits the inner sphere to return to a vertical position (by lunar gravity) after landing. The sensitive seismometer will then be in the correct attitude to transmit its data to earth.

As soon as the package comes to rest it will begin its data collection. Battery-powered, it is expected to continue transmissions for up to several months.

It is essential, said Aeronutronic engineers, that the capsule be capable of continuous operation in the rugged lunar environment. The temperature range is from  $-250^{\circ}\text{F}$  at night to as high as  $220^{\circ}\text{F}$  during the day.

To maintain a near-constant temperature within the instrument package, vacuum insulation is used. In addition,

3.6 lbs. of water ballast is included to aid in controlling temperature variations.

To avoid contaminating the moon, the entire *Ranger* spacecraft will be biologically sterile (M/R, March 24, p. 27). All internal instruments will be biologically sealed to insure against introducing contaminants.

• **Retro and spin system**—After release from the *Ranger* craft, the capsule package will include a retrorocket motor and igniter system; spin motor and igniter system; altimeter and antenna plus all necessary support structure. Total weight of this assembly is 325 lb.

Hercules Powder Co. is developing the small solid-propellant retrorocket. The almost 200-lb. motor is dynamicaly balanced to minimize alignment error when the capsule is spin-stabilized.

The three-jet spin rocket system for stabilization is being built by Aeronutronic. It will be located within the cone of the rocket nozzle.

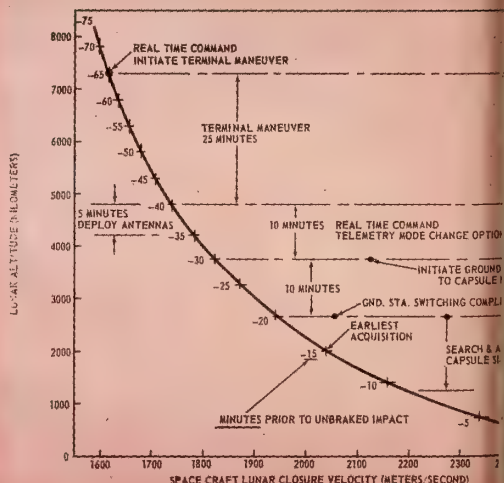
When the retrorocket is ignited, the entire spin unit is jettisoned.

A 5-lb. altimeter built by Will Electronics Co. will initiate the terminal phase of the *Ranger III* journey.

Since an accurate figure is not known for the distance between earth and moon, separation of the survival capsule cannot be programmed. A radio signal from earth will activate the

## Terminal Trajectory

Three curves trace final 75 minutes of *Ranger III* flight to hard impact of survival capsule on lunar surface.



# struments

altimeter as *Ranger* nears the moon.

The radar-pulse-type altimeter, using reflections from the lunar surface, will determine range accurately. At the correct distance, it will generate the separation signal.

• **New rocket design**—The capsule rocket assembly employs the latest in rocket design principles, according to Perceles.

The motor uses a sliverless, very-high-impulse, composite-modified, double-base propellant charge. The fuel is cast within and is bonded directly to a Spiralloy rocket case.

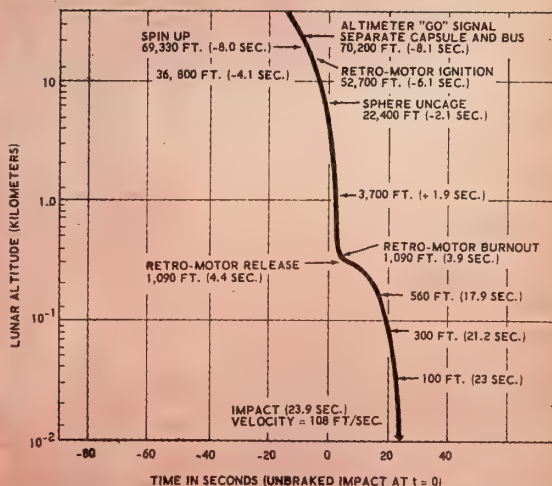
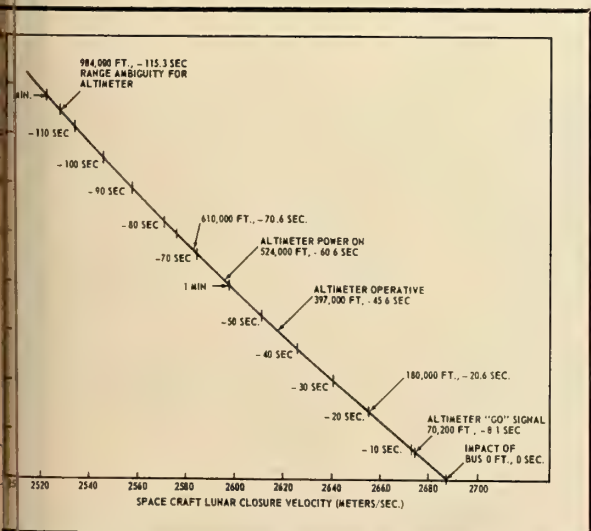
Composite-structure chamber consists of a forward plastic closure, aft aluminum adapter, insulator, Spiralloy vessel, and fore and aft attachment fittings. The chamber, insulator and aft skirt are all wound on a mandrel; the insulator of nylon-phenolic and the chamber and skirt of Spiralloy. The insulator is required to protect the Spiralloy chamber in the areas where the jets in the propellant charge expose the chamber to hot combustion gases during burning.

The loaded and assembled motor weighs 195.8 lbs. and measures 31 in. long and 18 in. in diameter.

Developers say a velocity increment of 9180 ft./sec. is produced by the retro-rocket for a 91.6-lb. load.



**SURVIVAL CAPSULE** built by Aeronutronic for JPL's *Ranger III* is shown in full scale. Top section is instrument capsule; lower section is retrorocket motor assembly. Two of three spin stabilization jets can be seen at bottom.





# Policy Split over Boosters Reported

**Golivan Committee is also said to be arguing about 'wasted' time; NAA wins \$140-million S-II award**

**BITTER CONTROVERSY** is understood to be raking the top policy group charged with working out a national space vehicle program.

The main sore points are said to be: A running argument over the relative merits of solid versus liquid big boosters; crossfire between NASA and DOD members of the group about the time being "wasted" in getting the lunar space vehicle program moving.

Lack of agreement on major issues among members of the Golivan Committee, which is to make a summary report to the White House by the end of October, become known amid these other developments:

—NASA awarded a \$140-million contract to North American Aviation Inc.'s Space and Information Systems Division for developing and building ten 800,000-lb.-thrust *S-II* stages for the *Saturn C-3*.

—NASA Administrator James E. Webb reported that an *Apollo* spacecraft contract may now be awarded before the end of the year.

—The space agency prepared to announce a bidders' conference, to be held late this month, on contracts to build first stages of the *Saturn C-1* and *C-3*.

Significantly, NASA announced in the *S-II* stage award to North American that it plans to use two *F-1* (1.5-million-lb.-thrust) engines to power the first stage of *Saturn C-3*. However, it is understood that this decision is still under review by the Golivan Committee, which also has yet to finally approve the scrapping of *Saturn C-2*. (M/R, Aug. 7, p. 13).

Informants told **MISSILES AND ROCKETS** that Aerospace Corp. members of the Golivan Committee were vigorously supporting solid lower stages for big boosters in opposition to NASA's Marshall Space Flight Center representatives, who were holding out for liquid. Said one expert close to the situation:

"The Marshall people are refusing

to admit that solid may be quicker and cheaper than liquids."

DOD members were complaining that the continuing deliberations were wasting time—that the problems involved in building lunar rockets already have been studied to death.

The committee is co-chaired by Dr. Nicholas Golivan, an assistant to the associate administrator of NASA, and by Dr. Larry Kavenau, an assistant to Defense Secretary Robert S. McNamara. Its recommendations are expected to set national policy on space boosters for years to come—including not only the vehicles needed by NASA but those required to support the Air Force's *Dyna-Soar* and manned space station programs.

Moreover, the committee is to report on "roles and missions" in the manned space program, the overall cost and its economic impact upon industry, and the degree to which industry is ready to undertake the enormous task.

• **Plans for \$35 billion**—On the point of economics, Webb told a National Press Club audience that NASA's space activities will pour some \$35 billion into the U.S. economy in the current decade.

Webb made several other disclosures about NASA plans.

He said that the U.S. will have to decide by 1965 whether to build a giant spacecraft, capable of holding 10 or 12 men, to be used for advanced lunar missions and planetary exploration. He said important space scientists believe

this follow-on to the three-man *Apollo* is feasible and necessary if the U.S. is to play a major role in space.

The top civilian spaceman also said:

• Development of ground support equipment facilities is the biggest problem facing the U.S. moon effort.

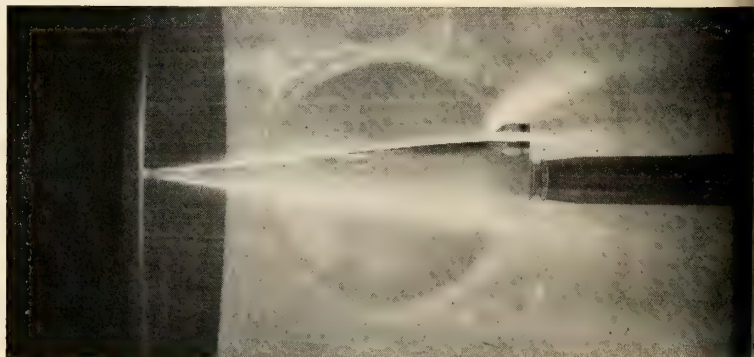
• A decision as to the location of NASA's \$60-million Space Research Laboratory may be delayed because more areas are being advanced as possible sites. He indicated that the site survey team—which wound up its work last week—may be forced to survey the new areas. One is Boston's outlying "golden semicircle."

• He is no hurry to name a head for the *Apollo* program or decide on a top management setup for it. It is much more important, at this point, to make "substantive" decisions such as the award of the *S-II* contract.

• A static-firing facility will be built in the general area of the Michoud La., plant which has been selected as the production site of the first stage of the *Saturn C-1* and *Saturn C-3*.

• **S-II plans**—The space agency said the *S-II* stage of four Rocketdyne J-2 liquid oxygen-hydrogen engines is planned as a second stage for the *C-3* version of *Saturn*. Coupled with its two 1.5-million-lb.-thrust *F-1* engines, it will be able to place a 40-ton spacecraft in a 300-mile-high earth orbit.

For missions requiring escape velocity, NASA said, a third stage with six 15,000-lb.-thrust liquid oxygen-hydro-



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en engines would be added to carry spacecraft weighing up to 15 tons.

"Tentative plans call for the use of Sturn C-3 to place the Apollo spacecraft carrying three men into orbit around the moon. Manned Apollo lunar landings will likely await development of a Nova-class booster requiring a cluster of F-1 engines in the first stage," NASA said.

Designation of a 40-ton earth-orbit capability for the C-3 apparently means that NASA still intends to build an earth orbiting manned laboratory. Coupled to the Apollo spacecraft's command module, the laboratory could orbit the earth for periods up to two weeks.

North American officials said that while the exact amount of subcontract-

## AF Moves Toward Bigger Profit Prospects

THE AIR FORCE is clearing the way for possibly higher profits on defense contracts.

This is in line with DOD support for such a plan as discussed at a June meeting of the National Security Industrial Association in Washington (M/R, June 26, p. 16).

Maj. Gen. William T. Thurman, Director of Air Force procurement, said that his headquarters "will favorably consider requests to exceed Armed Services Procurement Regulations limitations on fees." He said this applies to Air Force Systems Command and Air Force Logistics Command.

Thurman cited statements by both Secretary McNamara and Thomas D. Morris, Assistant Secretary of Defense (installations and logistics), supporting such action at DOD level.

## Facilities Bill Clears House

The House last week narrowly passed a compromise \$940-million military construction bill including \$27 million in additional missile and space facilities.

The bill still must clear the Senate.

The \$27 million was added to the bill by President Kennedy in his May revision of the budget. Nearly half—\$12 million—is for the Air Force solid superbooster program.

A special restriction written into the bill requires that specific approval must be obtained from the House and Senate Appropriations Committee before the \$12 million can be obligated.

## Weather Satellite Cost

Congressional testimony has disclosed that the cost of the Weather Bureau's program for developing a weather satellite is expected to run at about \$75 million a year for the next few years.

The figure for FY '62 is \$53 million, but it is expected to jump to the \$75 million level for FY '63—and stay there.

The present program calls for orbiting four more *Tiros* satellites before beginning the launching of the follow-on *Nimbus* weather satellites.

The breakdown for the \$53 million: \$38 million for satellites and launching; \$12.3 million for a data acquisition station near Washington, D.C.; \$2.6 million for data processing and management. The breakdown for the future \$75 million: \$50 million for operation of the system; \$25 million for support.



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## Senior members on the Golivan-Kavenau committee are:

Col. Otto Glasser and Lt. Col. David Carter, both on Gen. Bernard Schriever's staff.

H. J. Weigand, Office of AF Deputy Chief of Staff/Development.

Frank Williams and Wilson Schramm, both of NASA Marshall Space Flight Center.

Kurt Stehling and Eldon Hall, both of NASA headquarters.

Dr. Harvey Hall, NASA Vehicles Div.

Aleck Bonde, NASA Langley (Space Task Group).

Warren Amster, Edward Barlow and R. Brown, all of the Aerospace Corp.

Capt. L. J. Stecker, on the Chief of Naval Operations' staff and alternate for Rear Adm. Levering-Smith.

ing work generated by the \$140-million contract is hard to determine, it will probably be somewhere around 30% of a minimum figure.

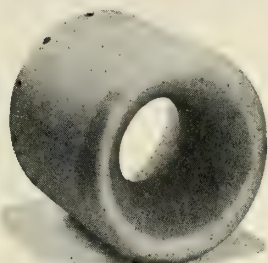
They said that the S-II stages for the C-3 vehicles will be assembled at a new facility to be constructed on a 15-acre site at Navy Ammunition Depot, Seal Beach, Calif. Subassembly and detail production will be at NAA's Aviation Space and Information Systems Division's Downey, Calif., plant.

After S-II assembly, it will be moved by surface vessel from Seal Beach to Port Hueneme, Calif., a Navy construction battalion facility, and by truck from there to the Rocketdyne plant at Santa Susanna for engine fitting and static test. After tests are completed, the stage will be trucked to Port Hueneme for shipment to Cape Canaveral, probably by barge. ❖



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## contracts

### NASA

\$81,240—Ling-Temco-Vought, Inc., Garland, Tex., for testing effect of space flight environment on *Saturn* instrumentation and for analysis of vibration in the *Saturn* space vehicle (two contracts)

### MISCELLANEOUS

\$2,286,751—Raytheon Canada, Ltd., a subsidiary of Raytheon Co. Lexington, Mass., for production of counter-missile radars for the Canadian Army.

\$350,000—Packard Bell Electronics, Los Angeles, from French firm SEREB (Société pour l'Etude et la Réalisation d'Engines Ballistiques) for production of an automatic checkout system for ballistic missile.

\$170,000—Daystrom, Inc., Pacific Div., Los Angeles, for follow-on production of special gyroscopes for Aerojet-General sounding rockets.

General Electric's Missile and Space Vehicle Dept., Philadelphia, from Lincoln Laboratory of Massachusetts Institute of Technology, for a *Trailblazer II* fourth-stage payload capsule that will powerdive toward earth from 190-mile altitudes as part of re-entry physics studies. Work is being done for Advanced Research Projects Agency.

### NAVY

\$2,383,000—Raytheon Co., Lexington, Mass., for added production of AN/SPG-51 fire control systems for use with shipborne Tartar missile.

\$1,000,000—Transdata, Inc. El Cajon, Calif., from Tele-Tronics Co. for manufacturing single sideband receivers AN/WRR-2 and AN/FRR-59.

\$700,000—Matthews Corp., Hawthorne, Calif., for production of advanced-design motor tubes for the *Sidewinder* missile.

\$192,000—Western Electric Co., New York City, for technical support to Bureau of Naval Weapons in connection with the Weapon Direction Equipment aspects of Naval Tactical Data System evaluations and tests, and aspects of feasibility studies and planning for new designs and improvements of *Terrier* and *Tartar* ship installations.

\$163,580—Texas Instruments, Inc., Dallas, for ten IP-414A/APA-12 azimuth and range indicators, and 450 transistorized voltage regulator retrofit kits.

\$63,357—Arinc Research Corp., Washington, D.C., for investigation of electrical parts failure data collected on guided missiles from the Naval Ordnance Laboratory, Corona, Calif.

\$31,032—The Martin Co., Orlando, Fla., for furnishing a technical and management team for the *Bullpup*-NATO Project.

### ARMY

\$37,000,000—Raytheon Co., Lexington, Mass., for work to be performed on the *Hawk* missile system.

\$4,800,000—The Martin Co., Orlando, Fla., for maintenance on Missile Master Air Defense Systems and installation of the smaller BIRDIE system.

\$4,576,000—Research Analysis Corp., Bethesda, Md., for operation and research.

\$2,980,000—Bendix Corp., Bendix Systems Div., for work connected with the *Advent* communications satellite.

\$1,582,824—Avco-Everett Research Laboratory, Everett, Mass., from Bell Telephone Labs, for conducting a program associated with the development of identification techniques for the Nike-Zeus A-ICBM system.

\$300,000—United Telecontrol Electronics, Inc., Asbury Park, N.J., from Signal Corps, for development and production of transponder sets used as tracking aids in drones.

\$257,831—Firestone Tire & Rubber Co., Los Angeles, for missile field engineering services.

\$190,848—Gillilan Brothers, Inc., Los Angeles, for *Corporal* equipment and components.

\$123,806—Aerojet-General Corp., Downey, Calif., for warhead and booster.

Ryan Aeronautical Co., San Diego, from Transportation Research Command, for prototype engineering for several configurations of flex-wing unmanned towed gliders. No amount disclosed.

### AIR FORCE

\$1,096,750—Lockheed Aircraft Corp., Sunnyvale, Calif., for electronic signal studies.

\$46,000—Astropower, Inc., Costa Mesa, Calif., from Flight Test Center, Edwards AFB, for design and production of water-cooled propellant injectors for use in experimental rocket engines.

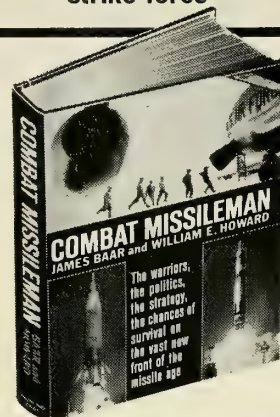
The Siegler Corp., Hufford Div., El Segundo Calif., from Aerojet-General Corp., for production of the cylindrical parts of the rocket motor case for the second stage of *Minuteman* ICBM. No amount disclosed.

Republic Aviation Corp., Farmingdale, N.Y., for a comprehensive investigation leading to improvement of structural design requirements for aerospace vehicles. No amount disclosed.

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# Wanted: Faith in Free Enterprise

**T**HOSE members of the industry providing ground support equipment for the missile and space programs face a clear challenge.

Part of it was spelled out by NASA Administrator James E. Webb in a speech last week at the National Press Club. He made it very plain that the pacing item in the vast *Apollo* program will be GSE.

If anything is to delay the take-off of the first lunar expedition beyond the earliest hoped-for date, Mr. Webb said, it will be the availability of facilities.

This is no surprise in view of the size and extent of the facilities required to support a manned expedition to the moon. Picture, for example, the gantry required for a *Nova* vehicle. It weighs nearly 4000 tons and towers 435 feet into the air. The industry has never before attempted anything like it.

Or imagine the facility needed for environmental checkout of an *Apollo* vehicle; advanced computers which will speed up the countdown; the handling equipment required for boosters of *Saturn* and *Nova* size.

Imagination is just what it takes to see this equipment. It does not exist. It must be designed, approved, built and tested. In some cases, the requirements don't even exist—because we don't yet know what they are.

Somewhere along the way, someone will have to spot the requirements, verify them, draw up specifications, call for bids, appraise proposals and let contracts.

All of this on a timetable which demands that the facilities and equipment be ready when the spacecraft and booster are ready to go. It is a task which staggers the boldest planner.

The fact that Administrator Webb has recognized the importance of GSE to the lunar program—and has, in fact, labeled it as the pacing factor—is a giant step in the right direction. Recognition of the problem by the man at the top is a mighty important aid to solving it. Too frequently, concern over GSE is left until too late for it to be anything but a problem; witness the troubles in the ICBM base program.

Recognition alone is not enough, however. The approach NASA takes to the solution will have a strong bearing on the success of the *Apollo* program. Once a GSE problem area is discovered, it should be passed to industry for solution—with a minimum of government interference.

The members of the missile/space industry who

are in the GSE field are a remarkably independent lot, from the roughneck contractor responsible for site construction to the scientist tinkering in his electronics lab with a new computer circuit.

NASA must have faith in their ability to meet the goals which are set. This is true not only in GSE but in all aspects of our space program. Industry must be allowed sufficient initiative to strike out boldly after objectives, and enough freedom to take the necessary risks. The lunar program is too big to be bogged down with bureaucratic procedures. If that happens, its vast size is a guarantee that it will collapse.

Freedom is our way of life and free enterprise is our system. NASA should demonstrate its belief in both.

Administrator Webb went on record with a breakdown of funding—80% to industry and 20% for in-house capability—that indicates he intends to rely heavily on industry management in various areas of the lunar program. We applaud the implication. We will, however, keep a skeptical eye on that 20%.

**I**MPORTANT AS IT IS, space is not the only challenge to GSE manufacturers today. Resumption of nuclear testing is bringing with it a complete reappraisal of missile GSE. Bigger bombs mean a new look at hardened-site requirements. Bigger bombs also mean new importance for mobile systems, airborne as well as ground.

All of this adds up to sudden revival of a market for which many forecasts have been on the gloomy side. With completion of the *Atlas* and *Titan* programs only a few years off, financial prophets have been bearish on GSE prospects.

That has changed abruptly since the first of the year. President Kennedy's decision to back the *Apollo* program as a prime national objective, taken with the new emphasis on missile GSE, brightens the 1961 market outlook.

Up to 50% of spending on missile/space programs over the next five years will be in the GSE field. In dollar terms, it will rise far above the current GSE outlay of \$4 billion to \$6 billion a year.

This brighter outlook carries with it both problems and responsibilities. We are confident our GSE makers can handle both. They should be given both—not just the problems.

William J. Coughlin



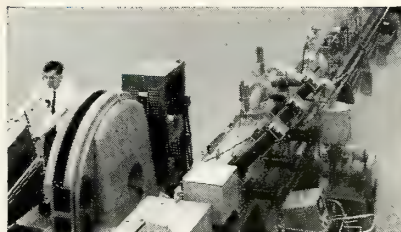
## *Missile or meteor?*

### ***GM's DSD tracks down the answer!***

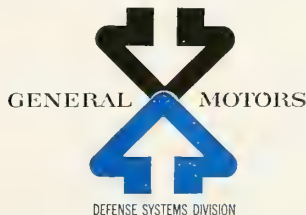
In the unique Flight Physics Laboratory of General Motors Defense Systems Division, studies are now in progress on hyper-velocity projectiles. Projectiles travel as fast as 31,000 feet per second through DSD's light gas gun. It is expected that speeds up to 40,000 feet per second will soon be attained. These studies provide clues to new missile detection methods and instruments which will identify the distinctive signatures of missiles and meteors. They will prove in seconds which they are and where they come from.

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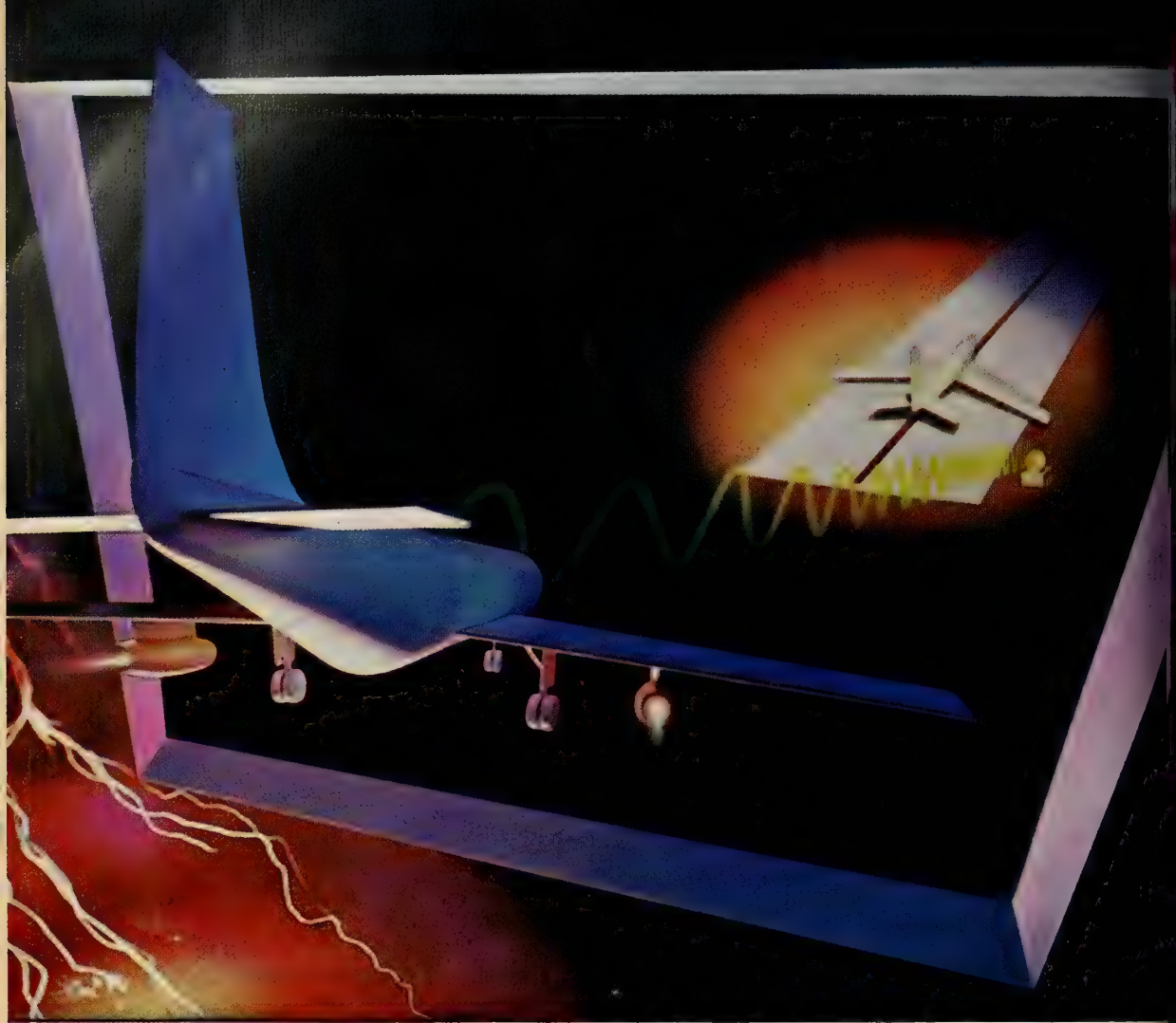


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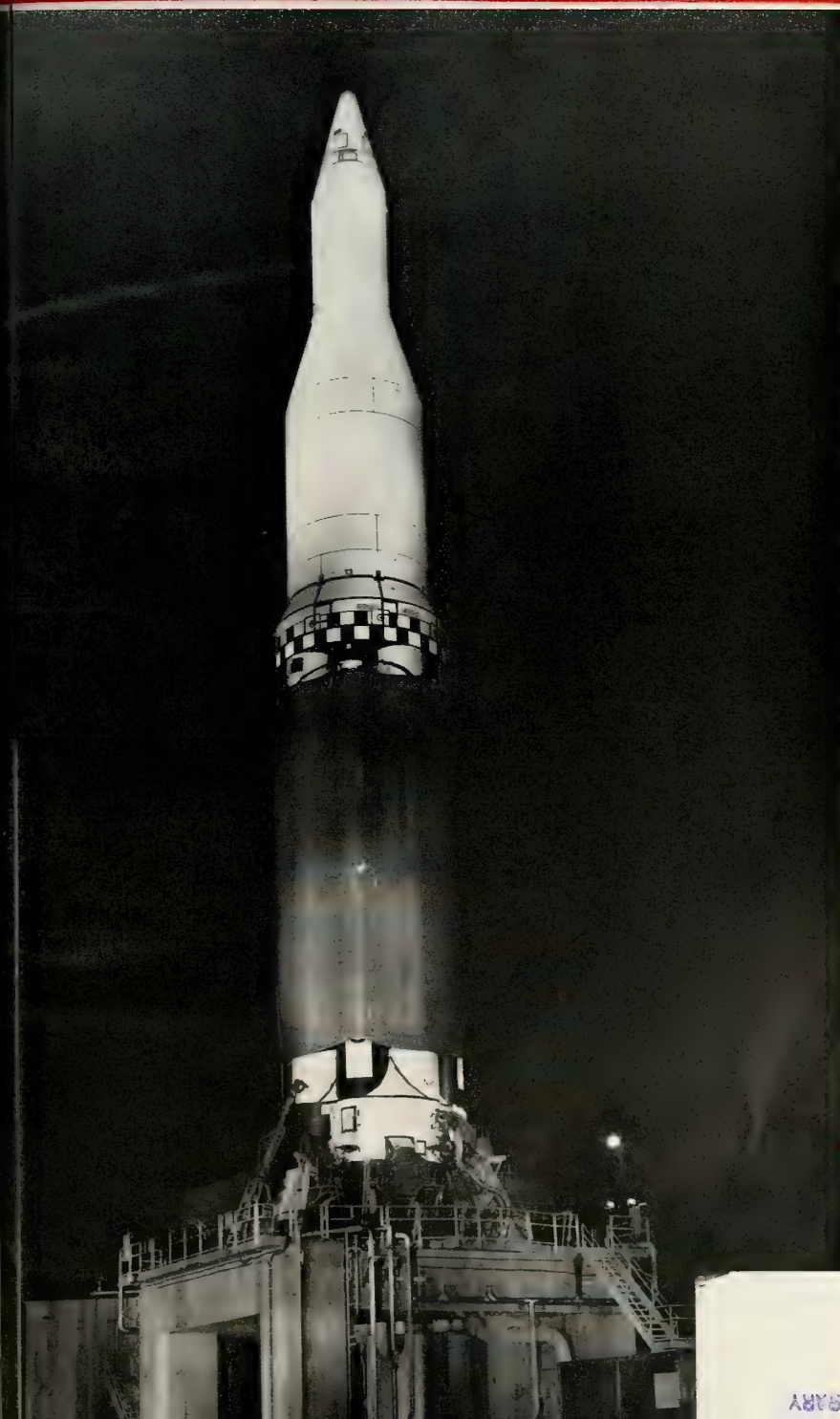
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# Missiles and Rockets

THE MISSILE SPACE WEEKLY

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## Special M/R Report On Scope of Electronic Warfare

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● **AF Overhauls  
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● **NASA Ponders  
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*Gantryless Saturn at Cape*

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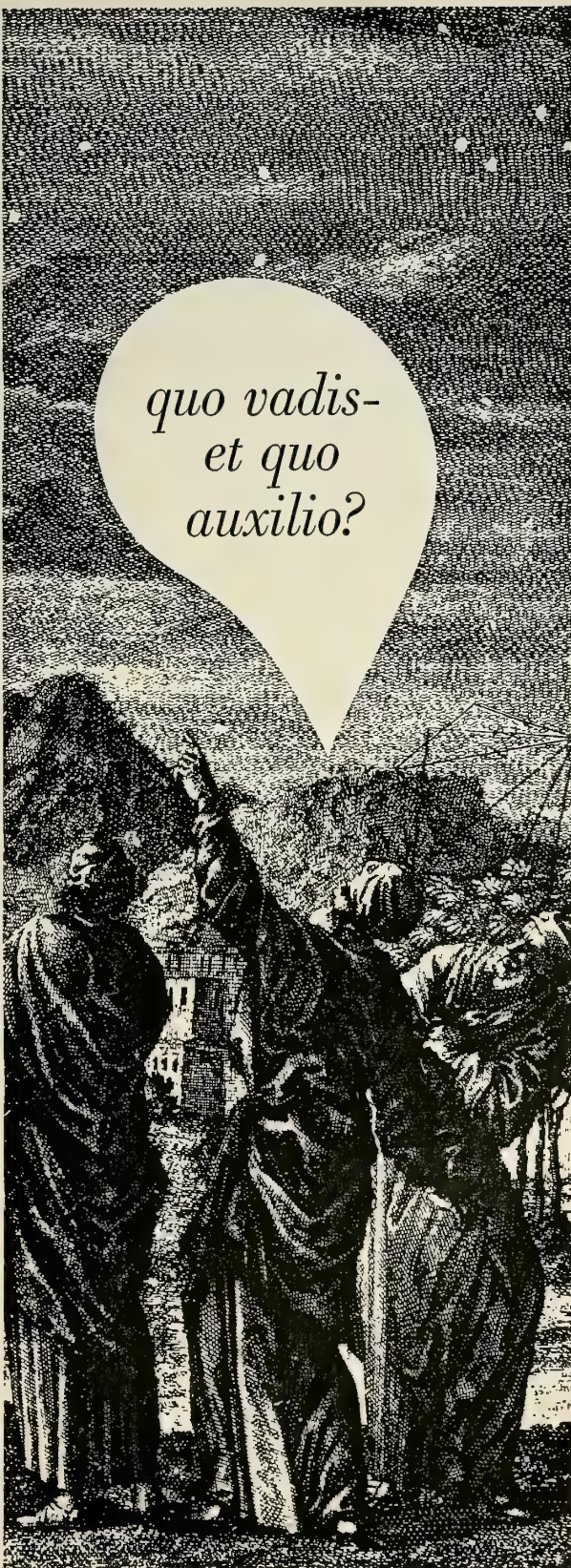
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# missiles and rockets

Volume 9, Number 13

September 25, 1961

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**THE COVER**

First Saturn C-1 at Cape Canaveral waits for  
scheduled launching in week of Oct. 9. This  
is first photo showing the 163-ft. vehicle with  
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† U.S. Reg. Pdg.

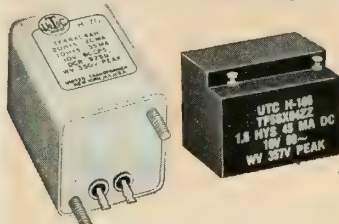
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**WRITE FOR LATEST CATALOG**

## memo from the publisher

AT LEAST FIFTY CENTS of every dollar spent for missile and space systems goes into electronic equipment and components. Over the next ten years, as the National Aeronautics and Space Administration's *Apollo* program and follow-on projects become a reality, this ratio is likely to increase.

For the past three years, M/R Electronics Editor Charlie LaFond has been spending at least fifty percent of his time (and sometimes, it seems, fifty percent of our money) traveling throughout the United States to cover missile/space electronics.

Even more impressive than the many thousands of miles he has traveled for M/R, however, has been Charlie's productive pen. Nearly every issue of our publication during the past several years has carried at least one technical article over his byline, the majority of which have stimulated orders for some of the more-than-400,000 reprints we've turned out during this period. We believe that the missile/space industry now recognizes this man as one of its outstanding and most capable technical writers.

We are happy to announce, therefore, the appointment of Charles LaFond as Senior Editor, following by just two months the appointment of M/R Military Affairs Editor Jim Baar to the same post.

LaFond is uniquely qualified in the area of missile/space electronics. In addition to studying electrical engineering at Catholic University and the Capitol Radio Engineering Institute, Charlie spent three years in the U.S. Army during and after World War II, attending no less than six military technical schools, including three in the communications field.

Before joining M/R, Charlie gleaned a wealth of information and experience from four electronics writing jobs in industry, including three years at Page Communications Engineers here in Washington, where he helped direct the preparation of all company publications and authored no less than nine technical books for long-range scatter communications systems.

LaFond has scattered his club affiliations as well, being a current member of IRE, ARS, AAS, NRC, NAC and AFCEA. If memory serves me correctly, all these impressive initials stand for Institute of Radio Engineers, American Rocket Society, American Astronautical Society, National Rocket Club, National Aviation Club and Armed Forces Communications and Electronics Association.



SENIOR EDITOR LaFond.

Between society and club meetings and his writing assignments on M/R, Charlie has found time to marry one of the most charming young ladies ever to leave English soil. He and Anne LaFond and their young daughter, Linda, live in Silver Spring, Maryland, where Charlie spends much of his practically nonexistent spare time planning a book on the subject of missile/space optics.

\* \* \* \* \*

LaFond's appointment as our new Senior Editor is the harbinger of things to come in expanded M/R coverage of missile/space electronics. Soon will place electronics editors in New York and Los Angeles offices provide more and even better coverage of one of the industry's most important and most problematical subjects.

\* \* \* \* \*

All of us here on the M/R staff have our hands full right now planning M/R's first Special Issue on NASA, to be published on November 27th of this year. With full cooperation from NASA headquarters, M/R editors will be visiting NASA installations throughout the nation during the next two months. Then, on November 27th, your morning mail will bring you the very latest run-down on NASA's programs, projects, facilities, budget, personnel and contracting procedures. Watch this Special Issue and remember the date: November 27th. It will be the most complete guide to NASA published.

*Edward M. Muehl*

# letters

## Anti-Gravity

To the Editor:

The title, "Practical Anti-Gravity Still Far Off" (M/R, Sept. 11, p. 28) would more appropriately be "Theoretical Anti-Gravity Still Far Off." The author of the article would be well advised to examine or re-examine Einstein's Unified Field theory and his (the author's) denunciation of it before he attempts another elementary analogy between gravitational and electrical fields.

Jerry Dean  
Rockledge, Fla.

The author of the article, Robert L. Forward of the University of Maryland Physics Dept., replies:

The analogies between gravitational and electromagnetic fields are well known by theorists in General Relativity (C.oller, "The Theory of Relativity," pp. 146 and 291; J. Weber, "General Relativity and Gravitational Waves," pp. 159-161, and others).

The particular equations used in this article were taken from the paper, "General Relativity for the Experimentalist," Proc. IRE, Vol. 49, May, 1961. A reprint will be sent to Mr. Dean.

If this particular method of obtaining anti-gravity is not acceptable, then there are at least three other, basically different ways to generate gravitational forces, using Einstein's Theory of General Relativity. All unfortunately are as impractical as the model in the article.)

For example, from J. Weber's book, p. 10, if you are inside a stationary massive sphere, there are no forces. If the sphere starts rotating, then according to Einstein's Theory of General Relativity, you will experience gravitational forces that will tend to lift you into the plane of rotation.

## Water Cost Spirals

To the Editor:

The article "U.S. Seeks Oceanography Instruments" (M/R, Aug. 28, p. 22) states that it costs \$16.30 to obtain a liter of water, and that this is equivalent to \$11.70 a fifth.

Actually, as it appears to me, it would cost slightly more per fifth. Since one gallon is 3.785 liters (as in ITT's Reference Data for Radio Engineers, 4th Edn.) the cost of one gallon would be \$61.70; hence the cost of one-fifth gallon is \$12.34.

G. A. Sabin  
Orlando, Fla.

## Building Ladies, Bless 'Em

To the Editor:

As a fascinated reader of M/R, I would like to bring to your attention the fact that there are many women now engaged in the construction industry. To point up this fact, Atlanta has organized a branch of Women in Construction.

(Continued on page 53)



## Talk with the leaders in high-energy fuel production and research...

at Booth 546, ARS "Space Flight Report to the Nation"  
New York Coliseum, October 9 through 15.

Callery Chemical Company, pioneers in the boron propellant field, continue an active research, development and production program on high-energy materials of the solid, liquid and hybrid types. New concepts of energy for outer space are also under study.

Callery engineers will be on hand at Booth 546 at the New York ARS show, to talk with you about developments in all phases of propellant research, applications and evaluation.

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**JOHNS-MANVILLE**  
THERMOMAT



# The Countdown

## WASHINGTON

### Big Boost for Solids

Plans for moving ahead with R&D of a solid superbooster now are expected to emerge shortly from the joint DOD-NASA committee which has been studying various proposals. Air Force and industry sources are optimistic that the solid superbooster can be developed considerably sooner than the big liquid *Nova*.

### Full Outlook: More Fall-Out

Watch for an announcement that the U.S. will resume nuclear testing in the atmosphere. The Defense Department is pressing for it—hard. Two of the key requirements: Testing of antimissile missiles and establishment of new parameters for hardened missile sites.

### Major Missile Decisions Ahead

The Kennedy Administration will be making major decisions within the next few weeks on a number of missile and aircraft programs. This will include a decision on the fate of the mobile *Minuteman* program. Meanwhile, Boeing's research and development contract for the railroad car-mounted *Minuteman* is being extended for a minimum period—three months—at a cost of about \$15 million.

### Changes in House Space Committee

Subcommittees of the House Space Committee will get more responsibility under the new committee chairman, Rep. George P. Miller of California (see p. 11). He is expected to allow the subcommittees to specialize in various scientific fields, laying to rest an objection of many members that opportunities were lacking to acquaint themselves with technical details of the space effort. Miller's Eighth California district, incidentally, lies along the east shore of San Francisco Bay, an area burgeoning with Space Age industrial firms.

### How Big is Big?

Pentagon brass hats still are debating the significance of Russia's boast it is developing a 100-megaton bomb. Defense Secretary McNamara says it is more a terror weapon than a military threat. But some military men contend the 100-megaton warhead gives added value to the *Polaris* weapon system and undercuts to some extent the survival chances of presently-planned fixed *Minutemen*.

### Still More Jobs at NASA

NASA soon will open recruiting offices in New York, Los Angeles and Dallas as part of its drive to round up some 2400 new employees, including 1500 engineers and scientists, by June 30, 1962.

## INDUSTRY

### Siegler V.P. Tapped

Siegler Corp.'s corporate vice president, John J. Burke, is slated for a top NASA post. NASA Administrator Webb will make the announcement himself shortly. Burke, who joined Siegler in 1956, formerly was executive vice president of Hallamore Division at Anaheim, Calif. Prior to that he was with Jet Propulsion Laboratory for nine years. He is a Cal Tech graduate.

### Happy Future for GE

If the future of precise inertial guidance and navigation in space lies with cryogenics, then General Electric appears to be rolling in clover. The company now has four major contracts in the field: one Army, one Navy and two NASA. Through its own investment in cryogenic R&D, the company also holds ten basic patents for cryogenic systems, devices and applications.

### Problem for Dyna-Soar

One of the toughest problems confronting engineers working on *Dyna-Soar* is that of assuring continuous communications. The spacecraft is threatened with an ionization communications blackout during several phases of its flight path.

### No Presidential Pressure

Although representatives of several states denounced NASA's selection of Houston, Tex., for the big new space lab as a political choice, Administrator Webb rested secure in the knowledge that President Kennedy wouldn't be complaining on behalf of Massachusetts. He had assurances from the President to that effect.

### More Money for Boron

Air Force is estimating cost of a new applied research effort on boron fuels at approximately \$1.5 million during the coming year. The program is to be carried out at the Muskogee, Okla., plant operated by Callery Chemical Co. Several rocket firms are expected to bid on the high-energy program.

### Follow-on for Dyna-Soar

Military follow-on to the *Dyna-Soar* vehicle has been tagged *Dyna-Mows* (*Manned Orbital Weapons System*). Two subcontract teams are working on competitive designs under Boeing direction. It will be larger than *Dyna-Soar*.

## INTERNATIONAL

### Indian Space Program

India now plans to build up its "big nation" image by establishing a rocket and space program. A Lockheed scientist is on his way to the Physical Research Laboratory at Ahmedabad, near Bombay, to assist in the programing.

### Japan Plans Rocket R&D

Some \$24.4 million for R&D work in hypersonic flight, rockets and VTOL/STOL aircraft is being requested by the Japanese Science and Technology Agency. The five-year program calls for research facilities for ramjet engines and for a rocket engine test bed.



# The Missile/Space Week

## Holmes Sees Major Job As Integrating Effort

New *Apollo* project director D. Brainerd Holmes believes the biggest problem he faces in the manned lunar program is one of integration.

The RCA official told M/R after his appointment last week that the toughest part of his job will be "integrating the vast numbers of people, industry and government agencies into one common effort as soon as possible."

Holmes, as Director of Manned Space Flight Programs, will report only to NASA Administrator James E. Webb and Associate Administrator Robert C. Seamans, Jr. He will be responsible for direct supervision of NASA's accelerating and expanding manned space flight activities—at NASA centers and in industry, the space agency announcement said.

Meanwhile, it was learned that further changes in NASA organization are in store as it moves to gear up for the *Apollo* program. Other

new program offices will be set up, and there will be some shifting of activities and responsibilities from the current setup to the new Manned Space Flight office.

It was also learned that the new *Apollo* management group will have some 300 employees and will be located in Washington.

Holmes—currently General Manager, Major Defense Systems Div., at RCA Defense Electronic Products—will assume his new position Nov. 1.

As Project Manager for Ballistic Missile Early Warning System (BMEWS) for RCA, the system contractor, he was responsible for coordinating for the Air Force a vast effort embracing the government and some 2900 US firms.

## Shots of the Week

A Soviet missile with a high-precision control system was fired 7500 mi. into the Central Pacific on Sept. 17. It was the second shot in the cur-

rent series, scheduled to last until mid-October. The first missile was launched on Sept. 14. Tass said the initial shot landed less than one kilometer (1094 yds.) from the target and that the second was in the same vicinity.

The Pacific impact area, bordered by the Marshall Islands to the west, Palmyra island to the east, Johnston Island to the north and Baker Island to the south, is 200 to 500 mi. shorter than the range of last year's Soviet firings. This has led to speculation that purpose of the shots is to test control system accuracy, rather than maximum range.

Soviet tracking ships are in the area. Moscow speculation suggests the tests might be a prelude to a new Soviet lunar firing.

Successes and failures meanwhile continued to mark U.S. launch attempts:

- The Air Force failed on Sept. 19 in its attempt to recover the *Discoverer XXXI* capsule, loaded with space radiation experiments. Capsule and satellite, launched Sept. 17, failed to separate and both remain in orbit.

- *Discoverer XXX* capsule launched Sept. 13, was recovered the following day in a mid-air snatch by an Air Force C-130 near Hawaii. It also carried radiation experiments.

- On Sept. 19, a *Bomarc* launched on command by the SAC center at Montgomery, Ala., intercepted and destroyed a supersonic *Regulus II* over the Gulf of Mexico. The *Regulus* was launched from Venice, Fla., the Boeing-built *Bomarc B* from Eglin AFB, Fla.

- Scheduled firing of a *Martin Pershing* from Vandenberg AFB, Calif. was cancelled on Sept. 19 for the second time within a week. Within five minutes of launch, the countdown was scrubbed for "technical" reasons. No rescheduling was announced.

- A two-stage *Martin Pershing* was fired on Sept. 13 from its mobile transporter-erector-launcher (TEL) at Cape Canaveral. The Army said test objectives were met, including test of the inertial guidance system.

- Army's firing of a *Nike-Zeus* at White Sands Missile Range on Sept.



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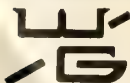
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5 also met all test objectives, according to official spokesmen. Launch as a controlled high-velocity test within the atmosphere during which the missile responded to control commands from the ground guidance center. Other objectives included further evaluation of the solid-fuel rocket motors and electronic guidance system.

• On Sept. 17, French and NASA scientists launched a *Nike Asp* rocket from Wallops Island, Va., in one of a series of spectacular tests releasing sodium and lithium vapor clouds at altitude. Payload contained 13.5 lbs. of thermite and 4.5 lbs. of sodium and lithium pellets. Ignition of the thermite by an electrical charge vaporized the pellets which then exhausted from a stainless-steel cylinder. The vapor, initially ejected at an altitude of 38 mi., extended to a peak altitude of 129 mi., appearing as glowing orange and pink clouds in the upper atmosphere.

### STRAC and TAC Merged

Defense Secretary Robert McNamara last week announced amalgamation of the three-division Strategic Army Corps (STRAC) and the Tactical Air Command (TAC) into a unified command.

### Miller Strong Space Backer

Rep. George P. Miller (D-Calif.), now chairman of the House Space Committee, is expected to support a stepped-up U.S. space program.

Congressional sources report that Rep. Miller, who fills the vacancy created by the death of Rep. Overton Brooks (D-La.), has consistently voted for the space programs of both the Eisenhower and Kennedy administrations.

### Flickinger Sees 30-yr. Gap

Just back from a trip to the Soviet Union, Brig. Gen. Don H. Flickinger (SAF, Ret.) takes a gloomy view of U.S. chances of catching the Soviet Union in manned space flight.

One of the nation's top space medicine experts, and until a few weeks ago Bio-Astronautics Deputy to the Air Force Systems Commander, Gen. Flickinger predicts it will take 30 years to catch up with the Russians in this field. He proposes that all U.S. space organizations be combined into a fourth military service to get the job done.

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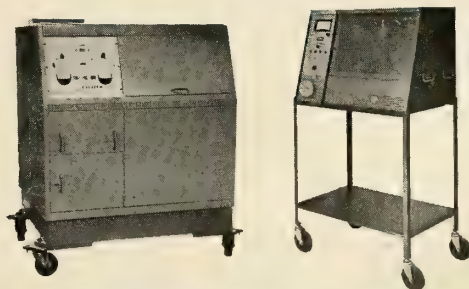
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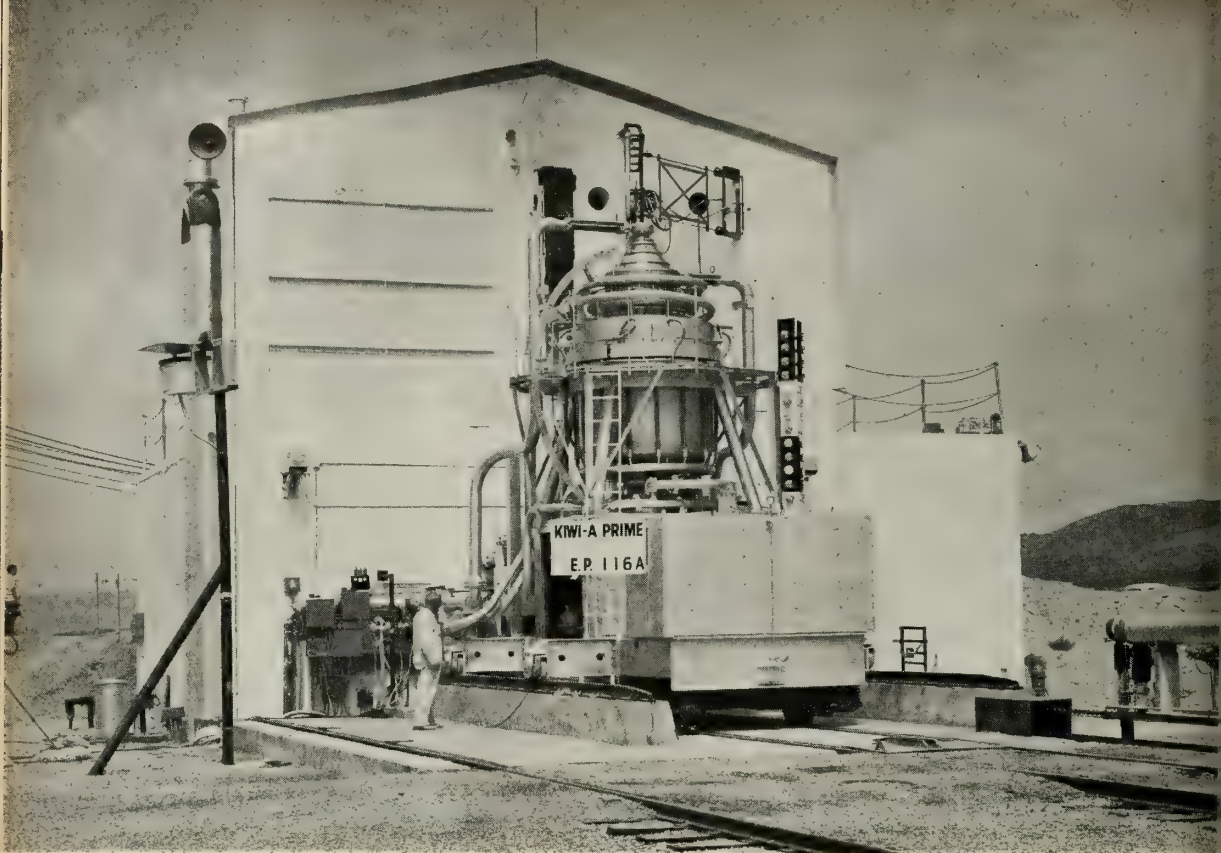
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*KIWI A-PRIME was given first full-power run on July 8. Some charge building lag caused 6-month delay.*

**Effects debated . . .**

# Construction Delays Hit AEC

***Field officials charge rocket hardware testing has been set back; less serious view is taken in capital***

**by Frank G. McGuire**

CONSTRUCTION PROBLEMS as serious as those which have plagued ICBM base activation have cropped up in the nation's nuclear rocket and weapons programs.

Considerable delay in the developmental testing of hardware in the nuclear rocket program has resulted, according to Atomic Energy Commission field officials.

Due to the nuclear test ban, the delays apparently have not seriously affected development of nuclear weapons—as yet. But the situation, while not new, is said to be getting worse.

Blame for the stoppages has been placed both on the construction firms building test facilities and on the unions involved. Teamsters, plumbers, electricians, and even security guards have been accused of walking off vital jobs “and sulking in the corner when things

didn't go their way”.

The situation has been labeled by one AEC spokesman as “the most disgusting exhibition yet of irresponsibility during a period of national crisis.”

The blame for delays does not rest entirely with contractors and labor unions, however. Late delivery of vital equipment and AEC changes in specifications also are partly responsible.

William Ogle, alternate test division leader at Los Alamos, told the Joint Congressional Committee on Atomic Energy late last month:

“I have searched hard to find at one organization or set of people I can point to and say it is their fault. There is no such thing as far as I can find.”

Regarding AEC's own role, he commented: “We have taken a little time to put in criteria, we have made changes

in the field, we have had normal types of delays in letting contracts and so on."

One source accused contractors in AEC construction programs of bidding low on a job in order to get the contract and then, with the job 90% finished, cutting manpower to the bone to save money. As a result, the remaining ten percent of the job slips past deadline due to contractor efforts to complete it with inadequate manpower.

There also have been slowdowns due to late delivery of special cryogenic materials, including piping and valves.

In several cases, after a job delay of months, the user of the facility was forced to apply the finishing touches, it was charged. Some lost time was made up by sacrificing less important quality requirements for such facilities, it was said.

AEC officials in Washington said this charge was exaggerated, however.

"In no case has the user of a facility had to apply finishing touches, except where changes to the original scope of the contract were made on an installation for the benefit and convenience of the government," a spokesman commented.

This comment from those concerned with management of the programs contrasted with reports received from operational personnel.

"As an example of what this sort of nonsense has cost us," a source close to AEC told M/R, "we could have tested Kiwi-B last fall, and now it will probably miss its scheduled firing next month. We may not get it tested until early in January, at this rate of progress."

This was questioned by those in charge of the program.

"In all probability," AEC commented officially, "modification of Test Cell A will be completed in time for the scheduled firing in mid-October. This has been the date for some months, although it was once scheduled for July. Construction delays are not entirely to blame for the slippage."

• **Low bid wins**—According to the rules under which construction contracts are let, the low bidder is selected even though his inadequacy for the job may be obvious, one source complained.

"And to make it worse," he added, "AEC refuses to put penalty clauses in these contracts to make certain the contractor performs. We can have a completely new reactor built and ready to test before they get a test cell constructed."

Another source in AEC's complex said the same problems have been experienced in other phases of nuclear activity. Sandia Corp., a nuclear-weapon research and development center which is now also doing some work on spacecraft, has had a major facility—its

Sandia Engineering Reactor Facility (SERF)—delayed over a year due to contractor troubles. The building was scheduled for completion in 1960; it now "may be operating" in early 1962. When completed, it will be used to expose materials and components of nuclear weapons and other systems to radiation.

"Some of the delay is certainly due to the change orders we have made in the plans for our Nevada Test Site (NTS) rocket cells," a third source close to the programs conceded to M/R, "but this is greatly aggravated by the fact that the contractor often has no experience in building R&D facilities, and his people haven't the sense of importance needed to do it right. As a result, the entire job is sloppily handled."

He added that almost every succeeding major construction job at NTS has gone to a different contractor and architect-engineer because of poor performance by the firms which handled the previous job.

"If we had expected this much trouble in getting our new cells built on a staggered schedule," he asserted, "we would have told Los Alamos Scientific Laboratory to keep at least one test cell ready for continuous reactor runs. Instead we now have all our test cells down for construction or modification, because of slipping schedules, and can't run any tests until the contractors finish."

• **Casualty list**—Work on AEC's newest nuclear rocket Test Cell "C" is now at least six months behind original schedule, and may slip further. The testing delays, in terms of actual time, were listed as follows:

—Kiwi A—could have been tested one year earlier than it was.

—Kiwi A-Prime—delayed six months.

—Kiwi A3—not delayed.

—Kiwi B 1A—already four to five months behind schedule, and still not tested.

Kiwi B 1A has now been completely assembled and initially checked out, but much work remains to be done in mating, test cells compatibility, and other aspects of the program.

The sources interviewed by M/R were very critical of AEC's own enforcement of contract terms with companies doing test facility work.

The decision to throw a contractor off a job after lengthy delays is often postponed due to time that would be lost in phasing a new contractor into the half-finished job, it was reported. Result of this is to put the test considerably behind schedule and completely out of step with R&D work which has been continuing in the overall program.

Commenting officially on this charge, the AEC told M/R:

"In no case in the *Rover* program have there been enough grounds under government construction procedures to default a contract or 'throw a contractor off the job.'"

In general, the official AEC attitude is to regard the slippages in the nuclear rocket program as not very serious, particularly since there is as yet no requirement for the rocket in any weapon system.

This attitude has not been shared in the past by Congress, however. As recently as this May, a staff report submitted by the late Overton Brooks, chairman of the House Space Committee, recommended the *Rover* nuclear rocket program for a DX priority, the nation's highest. (M/R, May 29, p. 27).

That report called for selection of engine and vehicle contractors by the National Aeronautics and Space Administration "at the earliest practical date."

This has not been done, although NASA Administrator James E. Webb indicated in a National Press Club speech earlier this month that increased attention is being paid to the *Rover* program. He said a speed-up would include early selection of contractors.

The Brooks committee was concerned then with management of the program. It cited administrative delays in *Rover* in calling for more authority for the joint NASA-Atomic Energy Commission Space Nuclear Propulsion Office headed by Dr. Harold B. Finger.

This attitude is shared by some of the field officials closest to the program, who recommend a number of changes in administrative approach.

Among other things, it has been recommended that (1) the contracting system be revised so that a contractor would be under greater control regarding his ability and equipment to do a job on schedule, and (2) some sort of understanding be reached with labor unions involved, so that stoppages do not occur with the figurative frequency of "every ten minutes."

• **"Sabotage-by-neglect"**—One spokesman summed it up: "There is nothing to distinguish this program in importance from our ICBM base-activation program except that the missiles are a bit closer in urgency. We will all be staking our lives in a few years on nuclear rockets because of what they can do, and this is no time for sabotage-by-neglect to be allowed such a stranglehold on the program. The ICBM stoppage problem was solved partly by the spotlight of public awareness, but we don't have that advantage, and these selfish interests are holding us up . . . with dangerous after-effects quite likely."



# New Code Names Clue To Future AF Plans

High-level AF group  
meanwhile draws up  
report on military  
space requirements

by James Baar

THE AIR FORCE is disclosing the main outlines of its R&D planning for the next 10 years in an official document that sharply revises the designation system for all "aerospace vehicles."

The document provides code designations for a broad variety of new missiles and spacecraft which would give the Air Force the capability of conducting major defensive and offensive operations in space and deploying a highly mobile third-generation ICBM on the ground. Such missions have yet to be approved by the Kennedy Administration.

Code designations are provided for missiles launched in space from "aerospace vehicles" and from "ground vehicles other than railroad cars"—presumably such as trucks and overland trains.

Designations also are provided for missiles and spacecraft with missions such as interception and defense, delivering cargo and in-space refueling. And the designations indicate a strategic mission for spacecraft.

Contents of the document—Technical Order 1-1-81—became known as a high-level Air Force Ad Hoc Committee sought to put together at the Pentagon a new report detailing Air Force plans and requirements in space.

The committee—headed by Maj. Gen. W. B. Keese, director of development planning—comprises about 20 high-ranking officers representing various parts of the Air Force. Part of its study involves a review of the considerable number of past studies and reports on the subject including the recent Gardner Report of the Air Force Systems Command.

The committee's report is expected to be completed in the near future and forwarded to Gen. Curtis E. LeMay, Air Force Chief of Staff.

• **Familiar theme**—To date no formal military requirements for defensive and offensive military spacecraft have been approved or established by the Department of Defense. However, many top Air Force officers have argued for some time that requirements for developing such systems do exist and programs to fulfill them should be started.

Despite DOD laundering, some clear indication of this can be seen in the speeches before the Air Force Association Convention this last week in Philadelphia.

Gen. Bernard Schriever, commander of the Air Force Systems Command, said:

"The ICBM, which is still in its infancy, is the first space weapon. It will inevitably be followed—more quickly than some people realize—by new space weapons that are more sophisticated and potentially more powerful. For this reason the aerospace force of tomorrow must be able to operate in space and to

detect and counter any threat in that arena.

"Among the projected manned craft of the future we envision . . . the true aerospace craft that will be capable of flight both within the atmosphere and out in space."

Maj. Gen. Hewett T. Wheless, SAC director of plans, said:

"As air supremacy means control of the battleground today, space may eventually equate to control of the world. . . . It is not beyond the realm of possibility that this may require manned spacecraft which would orbit the earth in a continuous air alert."

• **Name changes**—Such statements take on considerably fuller meaning when placed alongside the technical order revising designations.

As for the employment of the designations themselves, they are expected to be used first with the Air Force's three ICBM systems—*Atlas*, *Titan* and *Minuteman*.

For example: *Atlases* in coffin launchers at Warren AFB, Wyo., and *Atlases* to be deployed in silo underground launchers at Plattsburgh, N.Y., are both designated SM-65.

The "S" stands for strategic. The "M" stands for missile. These remain unchanged (see charts). However, now two new letters—"C" for coffin and "H" for hardened silo—will be added. Thus, the *Atlases* at Warren would be designated CSM-65; the *Atlases* at Plattsburgh, HSM-65.

Similarly, there would be two designations for *Minuteman*: The HSM-80 stands for the silo-based missile; RSM-80 stands for the railroad-based missile.

The technical order also establishes a new series of numbers for missiles and spacecraft. New model numbers for missiles will run in a consecutive sequence beginning with "1." New model numbers for spacecraft space vehicles will run in a consecutive sequence beginning with "101."

Therefore, the designation for a spacecraft interceptor could be IJ-101. The designation for a truck-launched ICBM could be GSM-1.

None of the new designations are automatically retroactive. Changes will have to be initiated by the Air Force Systems Command, the Air Force Logistics Command or USAF Headquarters, depending on circumstances. Designations for new systems will be made through action by the Systems Command.

The first changes are expected to be the addition of launching environment codes to the designations for the ICBM systems. The first new designations using the new codes are expected to be given appropriately to the *Midas* and *Samos* satellite systems and the *Dyna-Soar* spacecraft.

## Designations for Vehicle Types

| Letter   | Title      | Description                                                                                                                                                                                                                                   |
|----------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G</b> | Booster    | A vehicle employed to launch and/or propel other aerospace vehicles                                                                                                                                                                           |
| <b>J</b> | Spacecraft | A vehicle designed primarily to operate in space                                                                                                                                                                                              |
| <b>M</b> | Missile    | A heavier-than-air vehicle with a capability of travelling within or outside the earth's atmosphere whose trajectory or flight path may be controlled by installed or remote control mechanisms and which is not designed for human occupancy |
| <b>P</b> | Probe      | An instrumented vehicle used to penetrate the aerospace environment and report back information                                                                                                                                               |
| <b>R</b> | Rocket     | A non-guided missile                                                                                                                                                                                                                          |
| <b>S</b> | Satellite  | An aerospace vehicle designed to orbit                                                                                                                                                                                                        |

## Designations for Missile Launching Environments

| Letter   | Title           | Description                                                                                                         |
|----------|-----------------|---------------------------------------------------------------------------------------------------------------------|
| <b>A</b> | Aircraft        | Aircraft-launched                                                                                                   |
| <b>C</b> | Coffin          | Horizontally stored in protective enclosure                                                                         |
| <b>G</b> | Ground Vehicle  | Launched from a ground vehicle other than a railroad car                                                            |
| <b>H</b> | Silo            | Vertically stored and protected below ground level                                                                  |
| <b>M</b> | Multiple Launch | Capable of being launched from more than one environment. Applicable only when type, model and series are identical |
| <b>P</b> | Soft Pad        | Stored on unprotected pad and launched above ground                                                                 |
| <b>R</b> | Railroad Car    | Launched from railroad car                                                                                          |
| <b>S</b> | Space           | Launched from aerospace vehicle in space                                                                            |

## Designations for Missions of Missiles and Spacecraft

| Letter   | Title                      | Description                                                                             |
|----------|----------------------------|-----------------------------------------------------------------------------------------|
| <b>B</b> | Communication              | Designed to receive, transmit, relay or reflect electromagnetic impulses                |
| <b>C</b> | Cargo and Logistic Support | Designed to transport materiel and personnel                                            |
| <b>E</b> | Early Warning              | Designed to provide early warning of attack                                             |
| <b>I</b> | Intercept-Defense          | Designed to be employed in Air Force defense missions                                   |
| <b>K</b> | Tanker                     | Designed to provide in-flight refueling of other vehicles                               |
| <b>N</b> | Test                       | Designed primarily for the purpose of testing vehicle design of a new or radical nature |
| <b>P</b> | Propulsion                 | Designed to launch space vehicles and/or place them in orbit                            |
| <b>Q</b> | Target                     | A guided missile employed in Air Force target missions                                  |
| <b>R</b> | Reconnaissance             | Designed for use in Air Force reconnaissance missions                                   |
| <b>S</b> | Strategic                  | Employed in Air Force strategic missions                                                |
| <b>W</b> | Weather                    | Designed for weather observation and reporting                                          |
| <b>X</b> | Research                   | Designed to explore and study the elements in the outer atmosphere and space            |

## At AFA Meeting:

### U.S. Survival Linked To Weapons in Space

PHILADELPHIA—The Air Force firmly linked advancement in technology, space weapons and national survival as a major theme at the annual Air Force Association Convention.

Maj. Gen. David A. Burchinal, director of plans in the office of the Air Force Deputy Chief of Staff for Plans and Programs, bluntly told hundreds of industry representatives and military men attending the meeting:

"If we lose (our) base of technological superiority we will be in serious difficulty. This principle is particularly applicable to our efforts in space."

The general delivered his key address only some three days after Defense Secretary Robert S. McNamara told a press conference that he was still studying whether to spend an extra \$85.8 million added by Congress to the defense budget for *Dyna-Soar*. He gave no indication when the study would be completed.

General Burchinal said:

"The last decade has raised some warning flags. In the face of major effort by the Communists to overcome our superiority we did not keep pushing our scientific effort—our research and development effort—hard enough toward new and improved weapons, new and improved delivery systems and new techniques for defense.

"We must now face that fact and recognize that it will require a major effort on our part to maintain the margin of technological superiority from which discriminate military superiority may be achieved and maintained."

Burchinal warned that in attempting to do this "our resources and scientific manpower, laboratories and other facilities are not unlimited." He said "they must be carefully husbanded, their efforts integrated and closely managed with purpose and clear objective to make maximum progress in minimum time."

• **Implicit commentary**—And then he added pointedly:

"Maintaining our position of pre-eminence is not merely a matter of national prestige. In the decade ahead, it may well mean survival."

Other speakers picked up bits and pieces of the theme, sketching in the details as to what kind of space weapons are needed. No one pointed fingers at the present national man-to-the-moon program mostly in the hands of NASA. But the message was there.



# Saturn Development May Be Speeded

SPACE AGENCY OFFICIALS—pushing hard to meet a mid-October target date for the first launch of the *Saturn* booster—are considering accelerating the *Saturn* development schedule.

The demands of the *Apollo* program are the prime reason for the expected step-up. NASA would like to cut some time off the 1964 date for operational *Saturn*s in order to speed *Apollo* spacecraft development. It is expected that funds to accomplish the speed-up will be requested in the Fiscal 1963 budget.

Officials report that preliminary checkouts for the first launch of the *Saturn* from Cape Canaveral "look good." Earliest possible date for the shot is the week of October 9.

If successful, the 1.5-million-lb.-thrust first stage will lift from its pad, burn for two minutes, shoot to a top altitude of 100 miles, and then sink ingloriously into the Atlantic some 200 miles downrange.

Besides proving that the U.S. answer to Russia's rockets can fly, other primary goals of the first launch include:

- The first test of the launching equipment, and the compatibility of the equipment with the space vehicle.

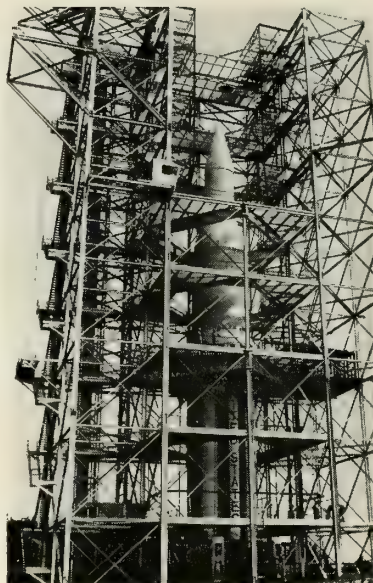
- Ascertaining the effect of the launch on the launch pad. Space agency officials know that the pad will be damaged during each launch, but how much and in what way must still be determined.

- Obtaining air frame information, including how the liquid hydrogen-oxygen propellant will feed during the launch and how maximum dynamic load will affect it.

- **Evolution**—The first *Saturn*—currently on its pad at Cape Canaveral—resembles its later prototypes only in outward appearance. Only the first stage—powered by eight H-1 engines developing 165,000 lbs. thrust each—will be live. The second and third stages will be dummies.

A similar vehicle will be used in the second *Saturn* launch scheduled early next year. While the shot will be similar, *SA-2* will have a new guidance system which will be a refinement of the *Jupiter* missile guidance system on *SA-1*.

Following in quick succession, *SA-3* is currently scheduled to go up in the third quarter next year. *SA-4*—for the first time—will include a live second



*SATURN C-1 assembled in its huge gantry. Height with dummy upper stages is 163 ft.*

stage which will have six LR-110 engines developing 15,000-lbs.-thrust each.

None of the first ten *Saturn* shots will have a live *Centaur* third stage.

Beginning with *SA-7*, boilerplate *Apollo* spacecraft will be test-flown. These shots will end with *SA-10*—now scheduled to wind up the development series sometime in 1964.

A successful *SA-1* shot would greatly enhance the chances of the development speed-up. Besides convincing Congress that funds for that purpose would be well spent, it would also enable the space agency to move ahead more confidently with the *Saturn* program.

- **Delayed conference**—Meanwhile, it was also learned that NASA expects to hold a bidders conference on the *S1<sup>b</sup>* stage of the *Saturn* sometime next month.

It was originally hoped that the conference could be held about two weeks following the bidders conference on industrial development of the *Saturn C-1* first stage, but indecision as to whether the *S1<sup>b</sup>* stage will have two or four F-1 engines has held up the proceedings.

Inability to decide on the final configuration of the *C-3*—or the *C-4* as it will probably be called if it does have four F-1 engines—stems from the lack of a decision as to the feasibility of the "rendezvous" concept of flight to the moon.

While this was earlier discounted by NASA, its adherents have recently grown appreciably more numerous. Officials report that while "direct descent" is still the most favored approach to a manned lunar landing, the chances of some form of rendezvous being used have grown stronger.

Officially, the space agency still holds that the *S1<sup>b</sup>* stage will have two F-1 engines. If the rendezvous concept is given final approval by a joint NASA-DOD committee, however, it is likely that a four-F-1-engine version will be built.

- **S-1 bidders**—The space agency last week invited 37 firms to attend a bidders conference on the *S-1* stage of the *Saturn C-1*, which will have eight H-1 engines.

The firms included Aerojet-General, American Machine and Foundry, Avco Corp., Beech Aircraft, Bell Aerosystems, Bendix, Boeing, Brown Engineering, Chance Vought, Chrysler, Douglas, Firestone Tire & Rubber, Ford Motor, General Dynamics/Astronautics, General Electric, General Motors, General Precision, Goodyear, Grumman, Hayes Corp., Hughes Aircraft Co., Kaiser Industries, Lockheed, Martin, McDonnell, Minneapolis-Honeywell, North American Aviation, Northrop, Raytheon, Republic Aviation, Ryan Aeronautical, Sperry Rand, Sylvania, Temco Electronics and Missiles, United Aircraft, Western Electric and Westinghouse.

The conference will be held at 9:30 a.m. at New Orleans Municipal Auditorium. The contractor selected will operate in a government-owned facility, 15 miles east of New Orleans, formerly known as the Michoud Ordnance plant. Bidders will have until October 16 to enter proposals at Marshall Space Flight Center. A contractor will be selected for negotiation probably in November.

It is considered that the list of firms invited to the bidders conference on the *S1<sup>b</sup>* first stage will closely approximate the roll call at the New Orleans conference.

## Ford Motor Buying Philco; Douglas to Close Segundo

TWO MAJOR DEVELOPMENTS marked the changing shape of the industry this week:

—Ford Motor Co. was moving to beef up its competitive position in the missile/space industry with the purchase of Philco Corp.

—Douglas Aircraft Co. announced a decision to close its El Segundo, Calif., plant due to the fading market for manned aircraft.

Pending stockholder approval, Ford will purchase Philco under terms of an agreement signed by both Boards of Directors.

In making the announcement, Ford Board Chairman Henry Ford II said the company's "purpose in purchasing Philco Corp. is to broaden its operations, to provide entry into new fields and to make possible a fuller participation by our company in the national defense and space effort."

In Denver, Ford president John Ekstra told the National Defense Transportation Association that Ford is moving into the defense and space business with both feet. We are determined to be in the vanguard of our country's effort to regain Space Age leadership." He said that as part of this Ford is making a determined effort in bidding on the first-stage booster of Saturn.

Meanwhile, Douglas plans to close its El Segundo plant because of what the company's Jackson R. McGowen calls "the inevitable result of a downward trend in aircraft production that has affected the entire aerospace industry."

McGowen, vice president-general manager of the Aircraft Division, said work at El Segundo, which produces the A4D attack aircraft, would be transferred to the Long Beach and Torrance, Calif., plants. The move will require approval by the Navy, which owns most of the facility. McGowen issued the statement "to set the record straight" after a group of International Association of Machinists union members threatened legal action to prevent closing of the plant.

A spokesman for the IAM group, speaking without union backing, said the company, under its IAM contract, has the right to transfer its operations to other plants but "has to offer its employees the right to go along." The official IAM position was expected late in the week.

In other industry developments: **NATIONAL COMPUTER ANALYSTS OF NEW YORK, INC.** has been formed to offer management consulting services to manufacturers and users of electronic computers.

Services will include initial feasibility study, evaluation of manufacturers' proposals, selection and training of client personnel, programming of the specific application, and implementation of the total system.

**ELECTROMAGNETIC TECHNOLOGY CORP.** has been formed in Palo Alto, Calif., as a research, development and engineering organization.

It will operate in the field of electromagnetic technology, with initial emphasis on R&D programs for industrial and governmental clients. EMTECH will also initiate company-sponsored projects expected to lead to development of proprietary electromagnetic devices and systems.



Douglas's McGowen

"... a downward trend in aircraft ..."

**COLLINS RADIO CO.** will complete work next month on two major Dallas area facilities. A manufacturing building will house special-product manufacturing and assembly functions, and a 24,000-sq.-ft. structure will house antenna research facilities.

**ASCON MANAGEMENT CORP.**, a marketing services organization, has established an Export Management Div. to assist California manufacturers of technical products in research, planning, administration, promotion and selling activities abroad.

**CORNING GLASS WORKS** has

established a Radome Department, operating as part of the company's Technical Products Div. The operation was previously part of Corning's New Products Div.

**TRANSITRON ELECTRONIC CORP.** announced a major change in its organization structure with the appointment of four Operations Managers. They will be responsible for operations of transistor, diode, rectifier and special product lines.

**LASER INC.** has been formed as a subsidiary of the American Optical Co. to do fundamental research in the laser field. It will be headed by E. Weldon Schumacher, president of American Optical.

AO says it is investigating, under an AF Aeronautical Systems Div. contract, a sun-powered laser that would use direct sunlight as a power source.

**DATA SENSORS, INC.**, Gardena, Calif., has been formed to engage in research, development, engineering design, and manufacture of electrical, electronic and electro-mechanical instruments used in data acquisition, conditioning and interpretation for military, space and industrial programs.

**RADIO CORP. OF AMERICA** has changed the name of its West Coast Missile and Surface Radar Div. to the Data Systems Div.

The division has been active in Automatic Program and Checkout Equipment (APCHE), designed and manufactured for the Atlas D, E and F series, as well as Digital Information Processor (DIP computer).

**AMP, INC.**, Harrisburg, Pa., consolidated its multiple-conductor electrical and electronic connector operations into a new Multicon Division.

The division will operate exclusively in the engineering and manufacture of multiple-conductor connectors. Products will include pin and socket type connectors, printed circuit board connectors, multiple coaxial connectors and related items.

**INSO ELECTRONIC PRODUCTS, INC.**, Nutley, N.J., has announced several organizational changes following its association with KPT Mfg. Co. and Shepherd Industries, Inc.

W. P. Turner has been appointed executive vice president, H. H. Heyden, vice president for sales, and Dr. R. E. Warner, secretary.

The three New Jersey firms have pooled management, manufacturing and sales capabilities.





# Funding to More than Double by '66

**Present bulk of spending is for aircraft EW equipment, but missile/space will go far into lead**

by Charles D. LaFond

THE MARKET for electronic warfare (EW) equipment in the missile/space field will more than double in the next five years—from well over \$50 million in Fiscal '62 to an amount exceeding \$130 million in Fiscal '66.

That is the EW market picture emerging from the best available industry estimates.

Today, the largest share of the EW expenditure goes for aircraft equipment. This will be altered radically in the next five years. By Fiscal '66, by far the heaviest volume of spending will be on equipment for missiles and spacecraft.

Current spending of more than \$50

million for EW in the missile/space field is part of an overall annual expenditure of some \$500 million to \$600 million on electronic warfare. That figure includes R&D and hardware for air and ground systems, all military services, the Central Intelligence Agency and the State Department. The State Department alone is believed to account for over \$100 million of the market, primarily in custom-built special receivers, analyzers and anti-intrusion devices.

Today's expenditure of some \$50 million on missile/space equipment and related ground hardware contrasts with aircraft EW spending in the neighborhood of \$140 million. But the Fiscal '66

volume of some \$130 million in the missile/space field will overshadow spending of less than \$90 million of aircraft equipment.

As used in this survey, the term Electronic Warfare includes all system directly associated with the art and technologies of electronic reconnaissance, surveillance, countermeasures, counter-countermeasures (ECCM), and simulators necessary to teach the technologies.

ECM includes all systems, active or passive, used to electronically jam, deceive, or confuse enemy radar, communications and electronically controlled devices.

## Major Electronic Warfare Contractors With Their Estimated Share of the FY '60 Market

| Contractor                        | Share of Market |
|-----------------------------------|-----------------|
| Sylvania                          | 18.7%           |
| General Electric                  | 16.5            |
| Airborne Instruments Laboratories | 14.0            |
| Subtotal                          | 49.2%           |
| Hoffman                           | 5.9%            |
| Sperry-Rand                       | 5.6             |
| Emertron                          | 4.0             |
| Hallcrafters                      | 3.9             |
| Loral                             | 2.6             |
| Westinghouse                      | 2.6             |
| Webcor                            | 2.3             |
| IT&T                              | 2.2             |
| Motorola                          | 1.4             |
| Emerson                           | 1.2             |
| RCA                               | 1.1             |
| Stanford University               | 1.0             |
| University of Michigan            | 1.0             |
| Raytheon                          | 0.7             |
| All others                        | 15.3            |
| Total                             | 100.0%          |

## The Electronic Warfare Market

(Direct Missile/Space/Aircraft Applications On'y)

|                                       | 1961          | 1962 | 1963 | 1964 | 1965 | 1966 | 1970 |
|---------------------------------------|---------------|------|------|------|------|------|------|
| <b>By Environment</b>                 |               |      |      |      |      |      |      |
|                                       | (\$ Millions) |      |      |      |      |      |      |
| Aircraft                              | 150           | 131  | 133  | 126  | 118  | 100  | 80   |
| Missile                               | 10            | 27   | 34   | 41   | 57   | 60   | 60   |
| Space                                 | 12            | 21   | 23   | 37   | 45   | 60   | 60   |
| Ground/Ship                           | 27            | 30   | 30   | 36   | 40   | 40   | 40   |
| TOTAL                                 | 199           | 209  | 220  | 240  | 260  | 260  | 240  |
| <b>By End-Users</b>                   |               |      |      |      |      |      |      |
| Air Force                             | 145           | 137  | 141  | 156  | 176  | 175  | 155  |
| Army                                  | 8             | 21   | 24   | 29   | 29   | 30   | 30   |
| Navy                                  | 46            | 50   | 53   | 51   | 51   | 50   | 50   |
| NASA                                  | —             | 1    | 2    | 4    | 4    | 5    | 5    |
| TOTAL                                 | 199           | 209  | 220  | 240  | 260  | 260  | 240  |
| <b>By Type of Equipment</b>           |               |      |      |      |      |      |      |
| Active ECM (Jammers)                  | 100           | 100  | 80   | 80   | 70   | 70   | 50   |
| Decoys & Repeaters                    | 39            | 39   | 60   | 60   | 70   | 70   | 55   |
| Ferret Intelligence and other Passive | 60            | 70   | 80   | 100  | 120  | 120  | 135  |
| TOTAL                                 | 199           | 209  | 220  | 240  | 260  | 260  | 240  |

• **Market environment**—The EW market during the past 15 years has shown an almost steady and continuous growth. This trend is expected to continue its upward spiral after a temporary leveling-off during the 1961-62 period.

In the past, the market was characterized by two facts:

—A majority of major EW systems and equipment was built for installation in aircraft.

—Better than 80% of the total EW market was for active electronic countermeasures (ECM) systems such as jammers and decoys.

Technological breakthroughs in modern weaponry, combined with the steady decrease in manned aircraft, have reoriented military EW requirements. Jammers alone no longer present a reasonably effective aircraft defense method and, while still required, are used in steadily decreasing numbers.

Concurrent with this development, Soviet advances in the field of electronic technology have made it imperative to multiply and diversify the means of an electronic intelligence at the disposal of the U.S. and NATO military establishments.

Passive electronic intelligence and reconnaissance techniques are suitable for all environments, but prove especially effective for long-range airborne exploration, and even more so for utilization within space vehicles. Advanced aircraft and space vehicles will employ complete ferret systems to provide intelligence on enemy electronic warfare equipment—including types of gear, bandwidths, location and power.

• **Changing trends**—Also, it should be noted that the EW market in the past was almost exclusively available in form of prime contracts. This situation is changing, although the bulk of the business will continue to take the form of prime contracts during the next several years. Significant changes in this structure are not expected prior to 1964.

The trend is now clearly running toward increased passive requirements, with the emphasis in future production changes from manned to unmanned craft. Following the expected peak in the 1963-1964 era, the trend should begin to reverse itself with a change to more active systems for use in missile systems.

Advances made just this year indicate a solution shortly to the communication problems of a re-entering warhead.

Aircraft will take a diminishing but still major portion of the EW production market through 1966. The biggest user

today is the Strategic Air Command. Although electronic warfare for missiles is expanding, this market alone is not expected to overtake the aircraft portion. It is in combination with the space market, largely R&D through 1966, that it surpasses aircraft.

As with most suppliers, the majority of electronic warfare competitors generally become identified with one branch of the military, and known for their competence in development and producing particular types of equipments or systems.

• **Detailed picture**—A major EW supplier has made a detailed analysis of prime electronic warfare programs which were awarded and reported over the last few years. These awards were extended over the contract period and an estimate was made by the company of all expenditures during the 1960 fiscal year, by contractor and by customer.

The awards were also identified as to type (active countermeasures, reconnaissance, or counter-countermeasures) and ultimate application.

This analysis covered a total of 75 government contractors which had expenditures on electronic warfare programs. The summation of these expenditures accounted for 73.5% of the total aircraft/missile/space electronic warfare market for FY 1960.

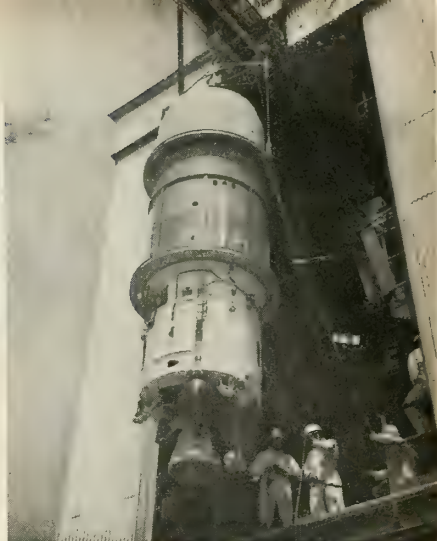
Results of this analysis shows that 15 industry contractors and two universities had estimated contracts of \$1 million or more on reported prime programs.

The expenditures to these contractors then were adjusted for such factors as classified programs, small contract awards and field service engineering in order to produce a more accurate division of the market. These contractors are aligned in accordance with their share of the market in the accompanying table (p. 18). The top three, Sylvania, General Electric and Airborne Instruments Laboratories, account for almost 50% of the total market.

Others having long experience in the field but not listed in the table include: Collins Radio, Hazeltine, Electronic Specialty Co., HRB-Singer, Sanders, Martin Co., Maxson, and Reflectone.

The strength of major electronic warfare competitors must be judged by considering many ingredients—experience, technical competence, program costs, delivery record, financial and physical resources, and desire of management.

Today's major electronic warfare competitors, classified according to their recognized strength in specific equipment areas, include: (active) Emer-



*NEW APPROACH* to global reconnaissance will begin with Samos. Built by Lockheed, the satellite will be capable of employing many types of electronic and photographic detection and recording devices. The system is scheduled to be operational by late 1962 or early 1963.

son, Emertron, General Electric, Hallicrafters, IT&T, Maxson, Motorola, Raytheon, Sanders, Sperry, Sylvania, Webcor, Westinghouse; (passive) AIL, Electronic Specialty Co., Hoffman, IT&T, Loral, RCA, Westinghouse.

In the active countermeasures area, Hallicrafters and Sanders appear to be the competitors to watch. Hallicrafters is rapidly gaining a significant share of the Air Force's barrage-jamming business, while Sanders has some of the most important Navy deception-jamming programs. In the reconnaissance field, Loral is making new inroads on ferret receivers for the Air Force.

• **The future**—Conservative estimates of the missile/space EW market show a leveling-off from 1966 to 1970.

Not-so-conservative estimates of the whole EW field put the total 1970 market between \$800 million and \$900 million. Those going "way out" on their estimates concur in this reasoning. They believe the great influence will be an acceleration in the deception (decoy) field.

They say the need will exist, the technology will permit it, but the question will be how much the military will emphasize development and later production.

Other disagree. They believe the "Berlin buildup," extension of SAC programs, growing emphasis on battlefield surveillance and radio frequency intelligence, plus continued high level of ship building and modification (FRAM) activity will cause steady increases. However, they see a leveling off after the mid '60's after the large production buys are completed. ■





# Research Effort Found Sadly Lacking

*Experts feel far greater emphasis must be given to development of new methods and components if needed 'upgrading' is to be achieved; weapon system tie-in blamed*

MORE EMPHASIS on EW technique and component development, higher power for active ECM, improved methods for analysis and discrimination of mixed radio-frequency transmissions—these are the most serious needs today in the electronic warfare field.

Most of the leaders in EW feel that our R&D effort is woefully inadequate. They see relatively little emphasis on the development of unique techniques and components—this despite the requirement for speed in "upgrading" selected electronic warfare components and techniques in order to successfully "match" the weapons they attack.

Unless this development takes place, EW is not likely to be of much use.

The consensus is that the lack of emphasis stems primarily from the fact that most of the dollars for technique and component development are tied to particular weapon systems—and are justified by them. Only those items that can satisfy the time scale and specific needs of the weapon system can be pursued. Because of this, significant gaps now exist in our background of information on components and techniques.

As a result we do not now have a good capability of configuring new systems quickly for effective use against specific sets of new "targets" as they arise. Our ability to wage effective electronic warfare is seriously reduced.

What is required, they assert, is that many more dollars be made available to support critical component and technique areas on a continuing basis, independent of any particular weapon system or other specific application of the EW art.

• **Discrimination**—Probably the biggest problem in passive ECM today is that of sorting. With the enormous increase in the use of radar for aircraft traffic control, aircraft landing aids, storm detection, marine navigation and even automobile speed measurement, determining just what is a threat and what isn't has greatly complicated the electronic reconnaissance problem.

Not only must all of these data be

recorded, but they must be analyzed to determine what are the threats, whether the old ones are still in use and whether there are any new needles in the proverbial haystack. For this, of course, a great deal of effort is being expended to utilize computers to assimilate and process these data.

• **Power**—For active countermeasures, more power is required. This requires more and more primary power from missile-carrying aircraft and greater and greater heat dissipating capabilities. To lick this problem, the tube and equipment manufacturers are making every effort to make their products more efficient.

Using the greater power output of improved jammers calls for better aircraft antennas and transmission lines. This major problem will be solved only with time and money.

With the advent of ballistic missile defense, offensive missiles will require ECM both active and passive. Needless to say, this is receiving much thought.

• **Time of essence**—Another constant problem in electronic warfare, possibly greater in this field than in any other, is time. There is an electronic warfare race—although it doesn't get the publicity of the missile race and the space race. For every new threat, a countermeasure must be found.

Many feel a major breakthrough was made when the Department of Defense in 1953 solved the time problem by the implementation of QRC (Quick Reaction Capability) for EW. Under this concept, the study, R&D, development, testing and supply of new hardware is compressed from seven years to less than one year, often weeks.

QRC, coupled with a broad, well-funded R&D program, could effectively minimize the time problem.

In passive EW, these are compelling requirements:

—Antennas that can provide (1) the frequency ranges required by improved aircraft receivers, and (2) the identification and location of signals of interest. Also, new antennas for satellite use that can meet the severe environ-

mental requirements and yet provide the required direction-finding accuracies.

—Automatic detection, surveillance and analysis systems.

—Rapid-scan, digitally programmed receivers.

And for active EW, here are some of the more stubborn problems:

—Techniques should be developed for using duct-mode propagation for really effective long-range communications jamming.

—Practical solutions to the plasma-sheath radiation barrier about nose cones must be found as soon as possible to permit effective use of active missileborne ECM.

—Techniques must be developed to permit control of aircraft and missile radar cross-section. This may include development of new or better dielectric materials for nose cones.

—Higher radar sophistication is required, using pulse compression, frequency agility techniques, and correlation devices.

—There is a need for better evaluation of countermeasures susceptibility of new radar systems.

—Training devices are needed to provide more realistic simulation of actual signal environment. These should supply more detail of antenna radiation characteristics and a variety of signal simulation of a countermeasure environment.

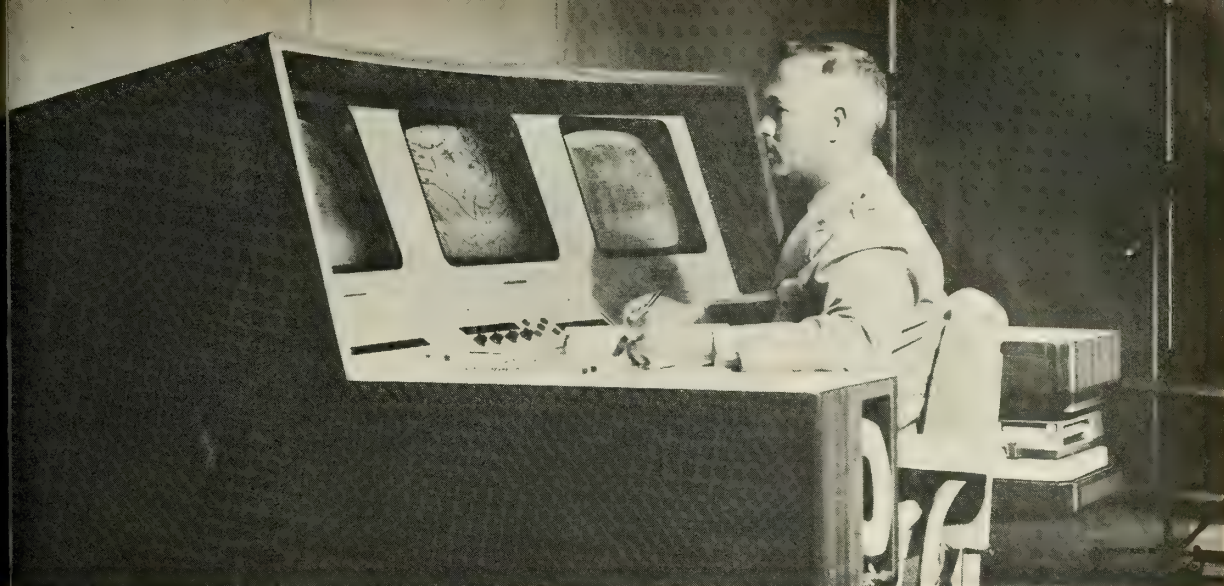
Finally, these are a few of the more general problems experienced by contractors in EW development programs:

—No one has ever established a complete and thorough operational program to confirm systems effectiveness.

—Too seldom are there accurate specification requirements mutually agreed to and understood by both contractor and customer.

—Too often is there completion of a development program, followed by the discovery that the final hardware is obsolete.

—Using the Quick Reaction Contract approach, it is often difficult to hold development groups intact while the hardware is being evaluated. This generates problems in subsequent production or improvement.



*TEST DIRECTOR'S console used to follow launch and orbital phases of Samos. Selected data of many kinds can be displayed on television screens or projected on wall-size screens.*



EW FUTURE

## More Active ECM for Big Missiles

**Another major development may be solution of plasma sheath problem; Samos to open doors in surveillance**

THE NEED for electronic warfare systems in the Space Age is assured; only their form and emphasis are in question.

The research effort today represents about 20% of the total EW dollar. Industry itself has almost an equal investment in current R&D. The total R&D effort appears to be divided almost equally between active and passive systems.

Principal change in the field over the next few years will be increased use of active electronic countermeasures (ECM) in ICBM and IRBM warheads. The plasma sheath problem may be on the way to final solution by scientists at the Hallicrafters' Research and Development Div. in Chicago.

In addition, the solution apparently offers a method to use the ion sheath to alter radar cross-section.

• **The vehicles**—The next military space vehicle to be introduced which

will call for broad EW use probably will be the reconnaissance and surveillance satellite developed essentially around the hardware for the ballistic missile. These vehicles, starting with *Samos*, are expected to become operational in late 1962.

Altitude capability for such systems will be somewhere between 200 and 1000 nautical miles, velocity will be about 4 nautical miles/second, and payload will be from 0.5-1 ton.

R&S satellites will certainly have significant parts in the electronic environment of the future. Many feel they will be flying in considerable strength by 1965.

After 1965, the manned *Dyna-Soar I* and *II* boost-glide vehicles will come to the front. If successful, they should lead to the development of still more advanced types: a high-endurance manned satellite or an orbital bomber. Orbital characteristics of the orbital bomber probably will be similar to those of the R&S satellite. The manned orbital vehicle will probably run to a considerably higher weight range.

• **The big change**—Beyond this point predictions cannot be made confidently; too much depends on technical breakthroughs yet to be accomplished. However, these vehicles offer staggering

potentialities and promise to revolutionize military thinking.

*Samos* alone opens the door for rapid continuous surveillance of enemy territory to secure up-to-the-minute intelligence data previously unobtainable. Here's how Forrest Cooper, Jr., manager of ECM engineering in General Electric's Light Military Electronics Dept., sums up the new situation in space:

"The ability of satellites to provide dependable worldwide communications will give attacking or counterattacking forces the benefit of extremely high vehicular performance. It is against such a background of vastly improved weapon capabilities that we must try to answer the question: What will be the role of electronic countermeasures?"

Effective defenses against space vehicles simply do not exist today—unless we accept counter-deterrence or massive retaliation as a reliable defense. The extent to which defense capabilities must be developed is a factor of the performance to be expected from the vehicles themselves. If altitude and speed alone are considered, Cooper asserts, this would mean about a tenfold increase over the figure for manned bombardment weapons—or air-breathing vehicles in general.

There is a good argument that these

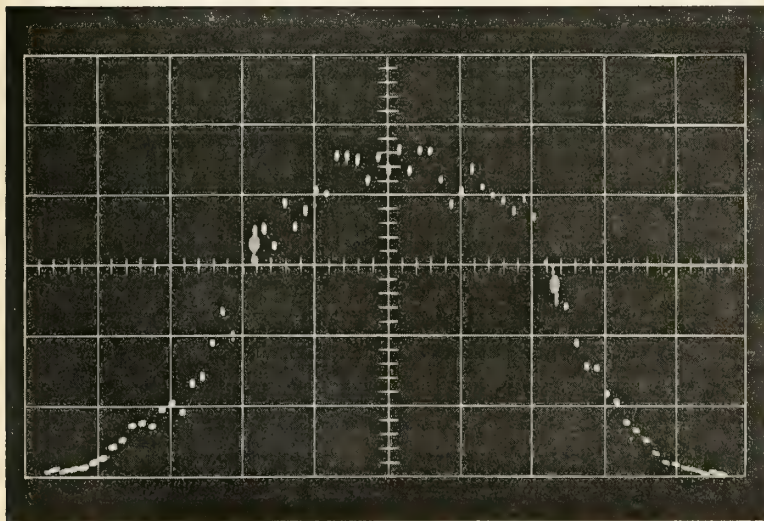
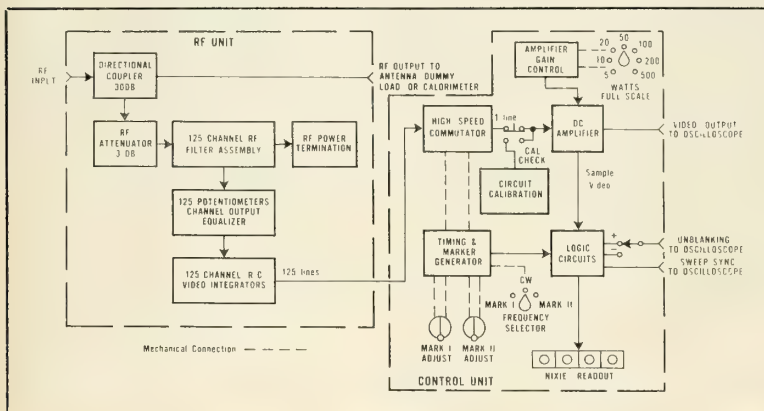
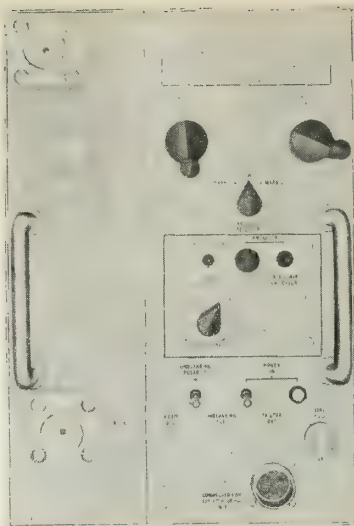


## New ECM Analyzer

**RIGHT:** First of its kind, Hallicrafters Incremental Power Spectrum Analyzer automatically plots and continuously displays power-vs.-frequency characteristics of r-f generating devices in the microwave spectrum. System is not only unique advance for determining characteristics of ECM-type transmission, but will find broad use in electronics laboratories.

**BELOW:** Block diagram of the analyzer.

**BOTTOM:** Typical oscilloscope display produced by the Incremental Power Spectrum Analyzer monitoring the output of a voltage-tunable magnetron modulated by f-m noise. Dots represent average power measurements in watts for 10-mc/s increments across the signal spectrum. The two bright dots are adjustable and calibrated frequency markers.



tenfold increases in performance can be achieved.

That consensus, Cooper says, is based on the fact that early warning and surveillance radars in a defense network must have maximum detection ranges an order of magnitude greater than comparable radars operating in a defense network against manned aircraft. The same line of reasoning holds true for local defense tracking systems, in addition to the increased accuracy required to provide a reasonable probability of intercept for a defensive missile.

Overall system gain of a radar system is proportionate to the fourth power of range capability of that system; it follows that the requirement of a tenfold increase in range capability involves the further requirement of a ten-thousand-fold increase in system gain.

So far, the required increase in gain has been accomplished by increasing both antenna areas and radar average powers one hundredfold, thus providing a net system gain of ten thousandfold—and also, unhappily, providing physically enormous radar systems. Components for systems such as those used in BMEWS have already been proved feasible. It also appears feasible to design and build the electromagnetic data-gathering systems needed for defense against space vehicles.

Further, there are properties of space vehicles that will help a defense network conduct a successful interception. Prediction of missile flight paths is practical. Similarly, the orbit of a reconnaissance satellite or an orbital bomber can be readily established.

One thing is certain. Whether the satellite system or the boost-glider is employed in the future, the result of their operating requirements—maximum altitude with little maneuverability or much less altitude with a little more maneuverability—offers an advantage for the opposing defense system.

Therefore, it can be seen that, based on the properties of space vehicles and in spite of their very high performance characteristics, these vehicles will not provide assurance of defense penetration with impunity. There is an objective need for effective countermeasures to baffle defensive radars and make the penetration easier.

• **Alternatives**—There are several approaches, in both the active and passive categories.

Because of their simplicity and particular suitability, various types of fragments can be used for deception or radar confusion. Space vehicles whose flight trajectory places them in a near-complete vacuum, could be surrounded with clouds of very lightweight radar-reflective matter ejected from the vehicle.

(Continued on page 31)

# He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4x8 matrix that can be mounted in a 19" rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

## Single Command Concept

AMF's imagination and skills are organized in a *single operational unit* offering a wide range of engineering and production capabilities. Its purpose: to accept assignments at any stage from concept through development, production, and service training...and to complete them faster...in

- Ground Support Equipment
- Weapon Systems
- Undersea Warfare
- Radar
- Automatic Handling & Processing
- Range Instrumentation
- Space Environment Equipment
- Nuclear Research & Development

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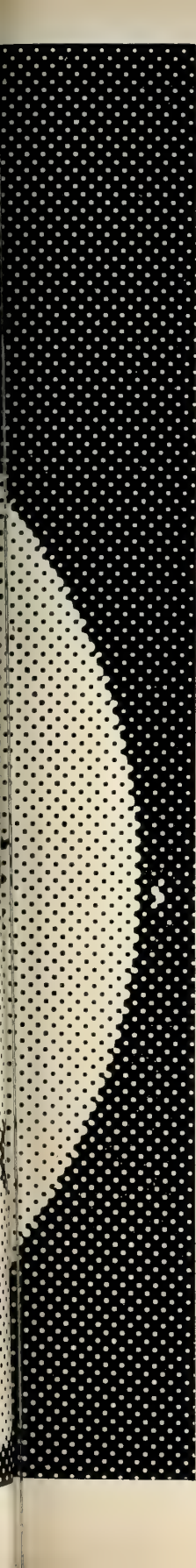
engineering and manufacturing AMF has ingenuity you can use...



# DIAL THERMOMETER



A Flexadyne motor 38" in diameter was cycled twice from  $-75^{\circ}$  to  $+170^{\circ}$ F. There was no internal cracking, tearing, or separation of propellant from its case. The motor then was successfully test fired at  $-75^{\circ}$ F.



**Another Rocketdyne Breakthrough:**

# **Flexadyne— first solid propellants with proven temperature capability**

From Rocketdyne, the pioneer in rocket propulsion, comes a family of advanced solid propellants. They are the first case-bonded solid propellants to offer superior performance proven throughout the broad temperature range of  $-75^{\circ}$  to  $+170^{\circ}\text{F}$ . They are called Flexadyne.

For multi-million-pound thrust solid propellant boosters, the use of Flexadyne means longer storage life, added performance. Air-launched missiles now can realize full mission flexibility without propellant cracking or bond failure due to extreme environmental temperature changes. No cumbersome "heater blankets" or other temperature conditioning equipment will be required for surface-launched missiles whether deployed in the frigid Arctic or blistering desert. Flexadyne's high resiliency promises maximum compatibility with extremely lightweight plastic rocket cases and resulting improvements in range and payload for any solid propulsion system.

The extended low temperature capabilities of Flexadyne propellants have been proven in numerous large-scale firings at Rocketdyne's Solid Propulsion Operations, McGregor, Texas. These tests culminated in the successful firing of a 38-inch diameter motor containing 3500 pounds of case-bonded propellant. This motor was fired at  $-75^{\circ}\text{F}$ . after two-and-a-half complete cycles from  $-75^{\circ}$  to  $+170^{\circ}\text{F}$ .

Through research, engineering, and management, Rocketdyne is constantly at work to increase thrust performance and develop new propulsion techniques of both solid and liquid rocket engines. Other forms of propulsion also are under study: hydrogen-fueled engines, nuclear engines, ion engines, plasma jets, magnetohydrodynamic engines. The work at Rocketdyne is the most comprehensive production and development program being conducted on rocket propulsion in the Free World.

*⎓ Rocketdyne's engineering skill and efficient production methods make it possible to power two missiles today for the cost of one in 1957. ⎓*

FIRST WITH POWER FOR OUTER SPACE

## **ROCKETDYNE**

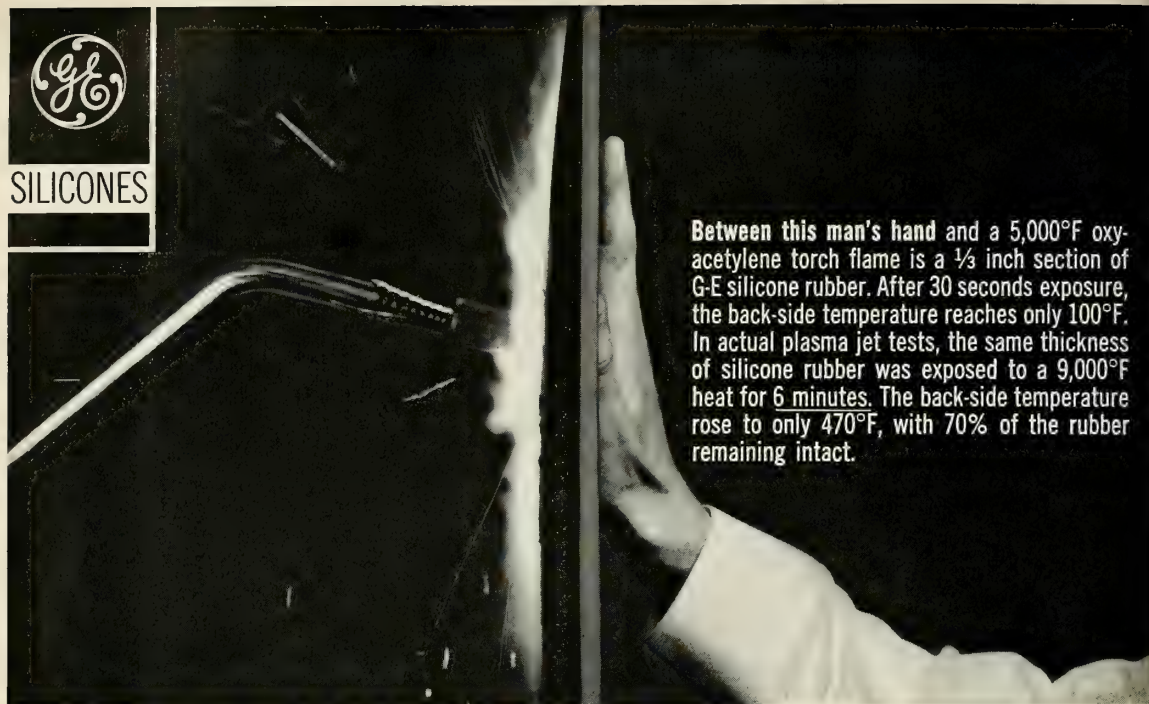
DIVISION OF NORTH AMERICAN AVIATION

Canoga Park, California; Neosho, Missouri; McGregor, Texas





SILICONES



Between this man's hand and a 5,000°F oxy-acetylene torch flame is a 1/4 inch section of G-E silicone rubber. After 30 seconds exposure, the back-side temperature reaches only 100°F. In actual plasma jet tests, the same thickness of silicone rubber was exposed to a 9,000°F heat for 6 minutes. The back-side temperature rose to only 470°F, with 70% of the rubber remaining intact.

## *Thermal barrier against 5000°F flame*

### *GENERAL ELECTRIC SILICONE RUBBER*



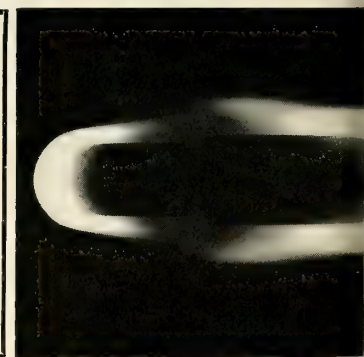
The surface of the tested rubber section forms a hard, carbonaceous crust, while the underside remains flexible and undamaged. Preliminary tests showed the effective heat of ablation to be eight times better than presently used plastics, with one-seventh the rate of ablation and one-fourth the weight loss. Here is an excellent ablative covering with low thermal conductivity.

#### RESULTS OF PLASMA JET TESTS AT 9,000°F

Flight Simulation  
Vel. = 17,000 ft./sec.  
Alt. = 250,000 ft.

| Exposure time<br>at 9,000°F | Back-side<br>temperature of<br>1/4 inch section of<br>G-E silicone rubber |
|-----------------------------|---------------------------------------------------------------------------|
| 30 seconds                  | 100°F                                                                     |
| 2 minutes                   | 210°F                                                                     |
| 3 minutes                   | 300°F                                                                     |
| 4 minutes                   | 375°F                                                                     |
| 5 minutes                   | 430°F                                                                     |
| 6 minutes                   | 470°F                                                                     |

The above chart shows how the high thermal insulation of G-E silicone rubber is maintained during exposure to 9,000°F heat. It is also useful in mechanical and electrical applications at temperatures from -150°F to 600°F, where it remains resilient and flexible. It also maintains its excellent physical and electrical properties over this wide temperature range for extended periods.



Continued high temperature testing goes on at General Electric's Missile and Space Vehicle Department in Philadelphia. Shown above is a typical specimen undergoing plasma jet testing in an electric arc heated supersonic wind tunnel. Continuous testing like this will develop new data on the thermal and ablative uses of G-E silicone rubber.

To learn more about G-E silicone rubber, and its uses as a thermal and ablative material, write: General Electric Company, Silicone Products Dept., Section 0961 Waterford, New York.

# GENERAL ELECTRIC

# Solution at hand for re-entry blackout problem . . .

(Continued from page 22)

le. Given a velocity slightly different from that of the weapon carrier upon re-entry, these fragments would move through space around the weapon carrier, making it extremely difficult for a radar data-gathering system to determine precisely which is the target.

Upon re-entry, many of the decoys would be screened away because of their low weight-to-drag ratio. Heavier pieces could be included among them, however, and these might follow the vehicle far enough into the atmosphere to reduce enemy interception probability.

Radar-absorbent coatings have possibilities, particularly for weapon carriers in vacuum trajectory, since these coatings will not be subjected to the intense heat encountered by aerodynamic vehicles.

However, it must be assumed that future techniques of radar data-processing will make it possible to sort out the decoys and identify the weapon carrier quickly. Also, detectors such as infrared sensors may provide the means for sorting out the decoy.

Because of these limiting qualities of such passive approaches, the main type of countermeasures for penetration aids will be active.

The rule of a tenfold system gain which applies to the defensive radar system does not apply to the offensive countermeasures system, according to Cooper.

Defensive radar systems, he says, will have increased their performance to the necessary level by increasing their radar power and the sensitivity of their antenna and receiver systems. Hence, at the rear there will be more radiated power, and considerably less received power than is found at conventional radars directed against manned aerodynamic bombers.

Jamming equipment that would be fully effective in these circumstances stands midway between the limits of higher radiated power and less received power—in fact, says Cooper, pretty nearly where it is in ECM equipments at the present day. In other words, he believes the power needed to jam defensive radars operating against space vehicles will be of the same order of magnitude as the power used to jam radars operating against manned bombers day.

If anything, the necessary ECM power level will be even less, because of a defense radar system in the Space

Age will be a pioneer development, operating close to the minimum requirement, whereas the current anti-bomber systems have had a number of years of development and design improvement, and operate well above the minimum.

The conclusion, according to Cooper, is that the physical size of an active ECM system for a space vehicle will be well within a practical range.

• **Future systems**—Barrage and spot noise jammers, confusion and deception jammers, can be used effectively against missile defense radars in much the same way they are now.

Also in the offing is long-range scatter-jamming from the surface of the earth. The same tropospheric and ionospheric scatter phenomena now used in long-distance scatter communications systems will be used to transmit microwave energy over the horizon. This might be useful as ECM for space vehicles because of the extreme sensitivity and wide coverage required of the defensive radars.

Also, as indicated earlier, the problem of communications blackout during the re-entry of a space vehicle may be solved by using a static magnetic field around the missile's antennas, according to Hallicrafters.

The feasibility of the static magnetic field approach was first advanced on February, 1960, by Henri Hodara, Associate Director of the company's R&D division. Since then, the approach has been expanded with further theoretical analysis and the design of a possible practical system.

The major finding of this advanced work is the fact that a static magnetic field of 500 gauss is sufficient to reduce the blackout significantly.

The original analysis, the company says, was based on plane-wave radiation through the plasma sheath. But according to Hodara, the plane-wave model is valid only as a first approximation.

It is accurate, he asserts, provided the plasma sheath is in the far field of the receiving and transmitting antennas. During re-entry, the sheath is in the near field of the transmitter, and its effect on the radiator's near field must be incorporated in the analysis; changes in the near field affect the radiation fields significantly when a plasma is present.

Recently, the radiation characteristics of long-slot antennas with a static magnetic field have been solved for the case of a plasma sheath in the near field.

Hodara's work on the radiation characteristics of long, narrow-slot antennas in the presence of a plasma sheath with an applied static magnetic field will be presented in detail at the

National Electronic Conference in October.

Results obtained so far on radiation characteristics of missile antennas during re-entry seem to confirm the possibilities of eliminating the blackout through this approach, Hodara said.

Since the earlier space vehicles are expected to be unmanned, completely automatic ECM equipment will be used by the mid-1960's. Even after manned space vehicles become operational, they will have quite small crews who will not be able to devote more than a minimal amount of time and attention to ECM system control.

Other systems now in development or recently available:

—The tunable magnetron developed by GE. Supported by the high-speed solid-state devices, it provides a countermeasures device of great agility.

—Sophisticated optical correlation methods. One major system has been built by Ling-Altec, others will follow.

—More effective modulation methods that can be used in the generation of jamming signals, available as penetration aids. (Results of a study by GE also will permit more effective use of the amount of power available for jamming and will help make jamming less susceptible to antijam devices.)

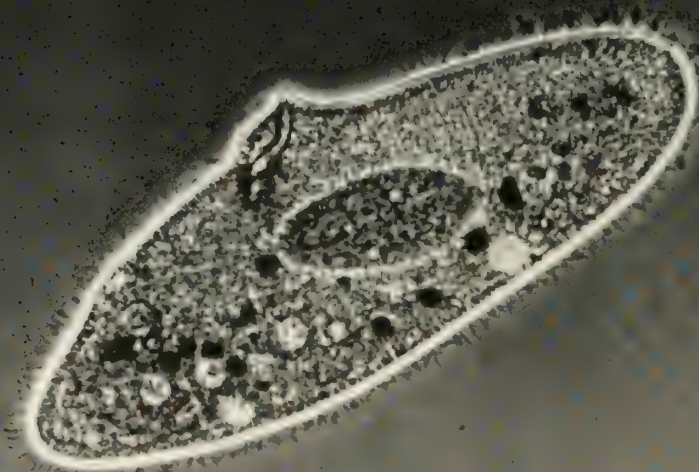
—Pulse compression techniques. These are being developed by many companies for an ECM receiver that can give a very rapid digital readout of all rf signals contained in an octave of frequency.

—A new concept in expendable communications jammers. This is being explored for the Army. It can render enemy communications useless over a broad part of the rf band and at the same time over a large band area. The system reportedly has a negligible effect upon friendly communications.

—Thermoplastic tape recording. This appears to be ideally suited for ECM, reconnaissance, surveillance and repeater systems. Such systems are in advanced development now by several companies.

—Traveling wave tubes. These will find steadily increasing uses in the EW field for radar jamming over a broad frequency range. (One of the most advanced systems of this type is Sperry Gyroscope's new ALQ-27. Now undergoing tests by Air Force in a KC-135 jet transport, the equipment was to have gone into production this year, but the contract was reduced to R&D in an economy move last year.)





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niques will be perfected. Then, spacecraft will be free of any organism that might upset our hopes of finding other life on other planets.

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EW BREAKTHROUGH

# WHIP Receiver Is Claimed Accurate to 1%

*Hallicrafters product, in final development, needs no active r-f devices, has perfect intercept probability*

by Robert Hankin  
and  
Monte Ross

*Research and Development Div.  
The Hallicrafters Co.  
Chicago*

A HIGHLY VERSATILE ECM receiver, capable of identifying multiple radio frequencies to within one percent accuracy, will soon be available. It holds this accuracy over an octave of bandwidth without tuning and achieves an intercept probability of 100%.

Called the WHIP (Wideband High Intercept Probability) receiver, the radically new system is now in final development. Designed and being built by the Hallicrafters Co., it uses reactive transmission line elements to provide completely passive frequency determination.

The basic approach, which obviates the need for conventional active r-f devices—klystrons, magnetrons, voltage-tunable magnetrons and backward-wave oscillators—was suggested originally by scientists at the Stanford University Electronics Laboratory.

The WHIP receiver, developers believe, will provide a lightweight, low-cost system for reconnaissance satellites, airborne or missileborne "expensible" jamming, and laboratory studies of r-f interference problems.

- **Unique combination**—The basic WHIP receiver consists of a wide bandpass filter and a passive frequency discriminator, in-

cluding two matched detectors, and can be employed with or without a pre-amplifier. Discriminator output can be displayed visually on a calibrated cathode ray tube or any properly calibrated oscilloscope. Frequencies are read out at angular lines in a manner similar for instrument pointers.

The multiple frequencies can be displayed simultaneously, providing the scope operator with an accurate picture of all frequencies seen by the receiver antenna, within the octave. When used in a reconnaissance satellite, the output of the WHIP receiver's detectors can be telemetered to ground stations and read out directly or digitized for feed-through to data gathering systems.

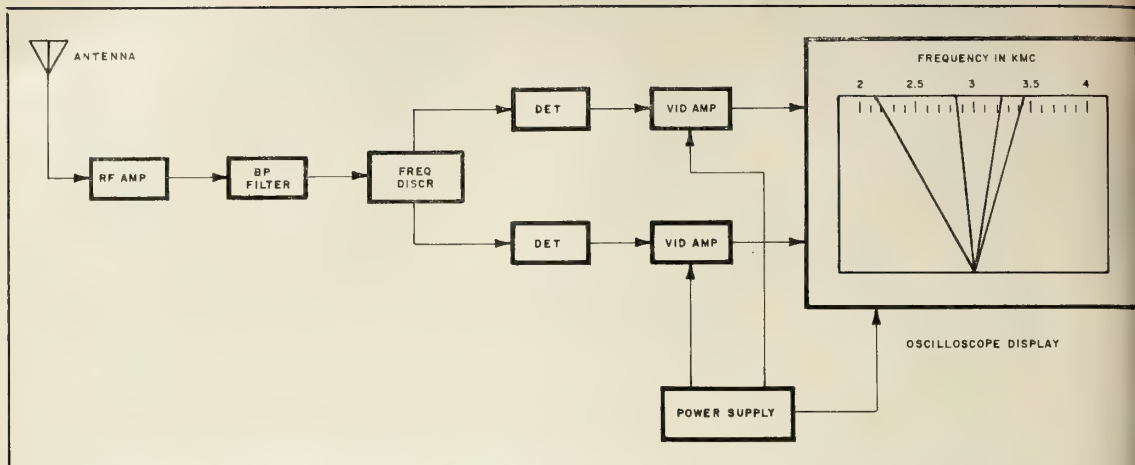
Unique among the receiver's many advantages is the fact that it gives frequency information over a broadband range of frequencies and at the same time gives 100% intercept probabilities. (Intercept probability being defined as detection of the signal when the system antenna is looking in the direction of signal emanation and the signal strength is higher than the system sensitivity.)

Normally, receivers may be divided

### Comparison of WHIP Receiver Characteristics with Crystal-video and Tuning Receivers

|                               | Crystal<br>Video Receiver | Tuning Receiver             | WHIP         |
|-------------------------------|---------------------------|-----------------------------|--------------|
| Intercept Probability         | 100%                      | Variable but less than 100% | 100%         |
| Sensitivity                   | Good                      | Very Good                   | Good         |
| Frequency Determining Ability | None                      | Very Good                   | Good         |
| Power Consumption             | Small                     | Largest by Far              | Small        |
| Size                          | Smallest                  | Largest by Far              | Intermediate |
| Weight                        | Smallest                  | Largest by Far              | Intermediate |





BLOCK DIAGRAM of Hallicrafters Wideband High Intercept Probability receiver with oscilloscope display.

into two basic types: (1) superheterodyne or tuning receiver, and (2) crystal video receivers.

The tuning receiver, although it may be swept fast, may be at one frequency when a signal occurs at another frequency, thus not giving 100% intercept probability. However, it gives good frequency information.

The crystal video receiver, on the other hand, gives 100% intercept probability but no frequency information. Frequency information is obtained in many cases from crystal video receivers by use of a large number of filters; this adds complexity, weight and cost—and still does not give continuous frequency information, but only discrete portions.

The WHIP receiver provides the frequency-determining features of a tuning receiver and the intercept-probability capability of a crystal video receiver.

Complexity of receivers has in the past, continually increased as demands

of more sophisticated performance grew. The WHIP receiver reverses this trend; it is much less complicated, requires less power, and is much smaller and lighter than usual frequency determining receivers. The small power requirements and the small size and weight make it especially suitable for airplane, rocket and satellite applications.

• **Favorable contrasts** — Detailed comparison of the WHIP receiver with the two basic types of microwave frequencies can be made in a simplified qualitative chart fashion as shown in the accompanying table.

Just as in standard crystal video receivers, sensitivity of the WHIP receiver can be considerably improved by traveling wave tube pre-amplifiers in front of the receiver. The specific sensitivity depends on bandwidth, frequency range, and component parts of all three types of receivers.

Power consumption of the micro-

wave tuning receiver is much greater than the WHIP because an active r-device is employed in tuning receivers. All of these use high power and high voltage for operation and constitute the majority of power used in these receivers.

The WHIP receiver employs no tuning but is wide-open over the band of interest. In addition, its frequency determining elements are passive and require no power.

The WHIP receiver is much smaller than the tuning receiver because of the lack of an active r-f device. The passive elements used can be made small. Weight is much reduced for the same reason.

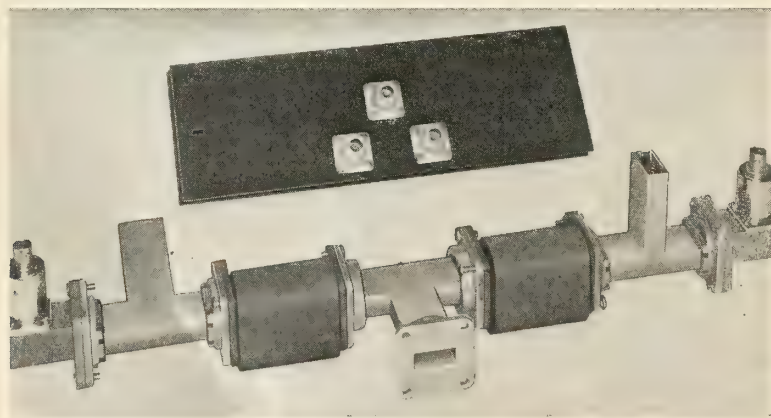
The heart of the WHIP receiver is the design of a broadband microwave frequency discriminator using passive sections and diode detectors only, exclusive of display or storage.

Several transmission line and waveguide frequency discriminators have been designed and built in the laboratory. Of these, one coaxial version has been tested at uhf and has exhibited good frequency resolution over the octave from 500 to 1000 megacycles. Another similar device designed as a stripline has been operated over an octave in S-band.

• **Broadband potential** — An approach to the design of a broadband discriminator in the waveguide frequencies has been confirmed by the successful operation in X-band of a unit of somewhat different design. This discriminator uses waveguide sections and detectors, but due to the limitation of the waveguide bandwidth, has less than an octave range.

The broadband frequency discriminators can be used with a very simple oscillographic display that displays frequency as a function of the angle of

(Continued on page 53)



COMPARISON IS SHOWN of uhf discriminator (top) and x-band discriminator (bottom) used in WHIP receiver. Such passive units permit detection of multiple radio frequencies to 1 percent accuracy.



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*If you live in the New York area, it may be more convenient to contact Mr. T. Cozine, General Dynamics|Astronautics, 1 Rockefeller Plaza, New York City, Telephone Circle 5-5034*

**GENERAL DYNAMICS**

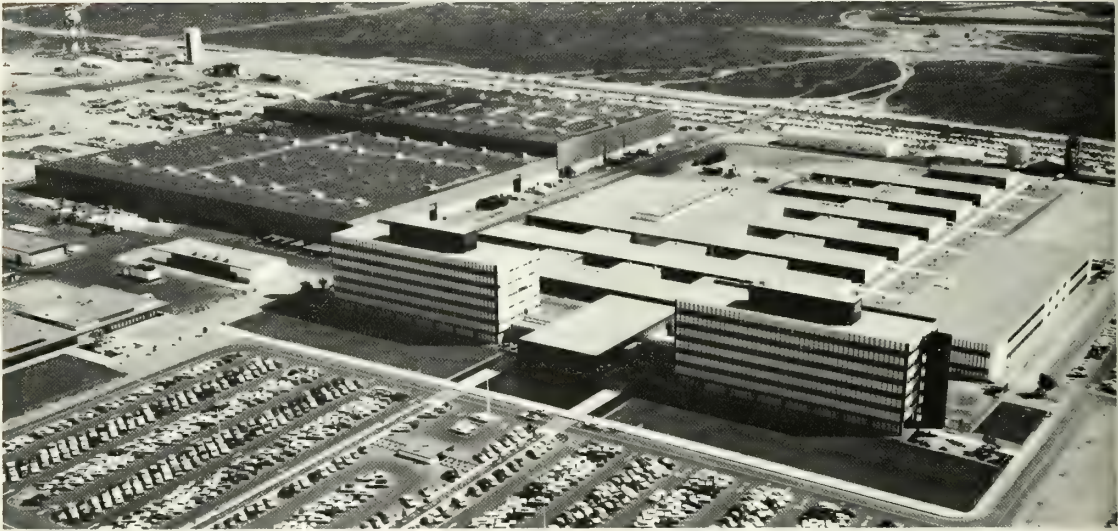


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## GENERAL DYNAMICS



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# Technical Countdown

## ASTRONAUTICS

### Study Outlines Space Radiation Levels

For a 14-day lunar mission, the total unshielded radiation dose to which astronauts may be subjected from the worst combination of trajectory and sunspot cycle is about 159 rem. This estimate based on studies conducted at The Martin Co. by *Apollo* project engineers emphasizes, however, that the dosage from solar flare protons—the greatest potential threat to the spacecraft crew—can be more than halved by using 94 lbs. of close-proximity “spot” shielding. Further reductions can be achieved by “a small degree of internal equipment redesign” and the already considerable shielding afforded by the heat shield and the spacecraft structure.

### Soviets Discuss Moon-Venus-Mars Projects

A two-stage space reconnaissance program—preparatory to manned flight—has been outlined in a brief article in Moscow's *Leninskoye Znamya*. The first stage—visual reconnaissance of lunar and planetary conditions with radio-controlled electron telescopic apparatus—will send to earth thousands of photos taken from various altitudes. The second stage—physical reconnaissance of the lunar and planetary surfaces—will be achieved by mobile research laboratories and research stations with receiving and transmitting radio apparatus and instruments.

### Retransmitting Satellite for Space Exploration?

For further radio communication with other planets it will be necessary to establish a satellite which will occupy an unchanging position relative to earth and Mercury and install on it a retransmitting station. This view—expressed by scientists in an article in the journal *Automation, Telemechanics and Communications* entitled “Radio Electronics and the Conquest of the Cosmos”—coupled with a description of the ion rocket's potential for “flights at a speed of 500,000 km per hour” gives an indication of the direction Soviet astronautics may be taking.

## MATERIALS

### Space Glider Gets Materials OK

Both materials and manufacturing processes essential to AF's space glider program are adequate for the job, according to the results of a \$1.2-million contract just completed by The Boeing Co. Rene 41 and HS 25 were chosen for construction of the glider because of their superior strength and heat-resistant characteristics. The new processes required to machine these metals are also available, Boeing reports.

### New Fabrication Method for Beryllium Presented

A new design concept using beryllium panels bonded to an aluminum substructure promises to minimize the usual difficulties with beryllium—including brittleness, high cost and toxicity. This is made possible, according to Boeing engineers, by the elimination of stress risers in the metal, the use of sheet material with little resulting scrap and no machining requirement.

### Space ‘Sandwich’ for Solid Boosters Studied

Application of the sandwich structural design concept

to solid-fuel rocket motor cases is being studied for the Air Force by North American's Space and Information Division. The research is divided into three phases: a feasibility study, construction and testing of subscale models and full-scale model tests with several static firings of the motor cases. The potential weight savings in large boosters is of prime interest.

## PROPULSION

### Ultra-Sensitive Thrust Measurer Delivered

A machine—so sensitive that it can measure thrust as gentle as one thousandth of a pound (about the force of normal breathing)—has been delivered to the AFSC at Wright-Patterson AFB by Rocketdyne. To be used to measure the thrust of ion rocket engines and other electrical propulsion systems, the machine can accurately measure thrusts up to 10 lbs. or any specified micrometric range in between.

## ELECTRONICS

### ‘Back Pack’ Power Supplies Scrutinized

A study contract awarded to Atomics International by the Army Signal Corps. is expected to yield information for the design of portable thermionic power supplies using fossil fuels. The areas that will be studied include thermionic converters, heat sources and high-temperature materials. Atomics International has recently announced development of a flame-heated thermionic generator that burns a propane-air mixture.

### Scatter Radar To Investigate Upper Atmosphere

Ground-based explorations of the upper atmosphere and outer space will be conducted by the National Bureau of Standards and the Instituto Geofisico de Huancayo at a new installation under construction 17 miles east of Lima, Peru. A 6-million-watt pulse transmitter and a 22-acre antenna with 9216 crossed dipoles mounted 6 ft. above a reflecting ground screen will be used to transmit a VHF wave for 50-1500 microseconds and then to detect the re-radiation of the pulsed radar wave by free electrons in the upper atmosphere.

### NAA Studying Reflecting Materials for AF

The Air Force is sponsoring an examination by North American Aviation of the problem of putting special materials on the *Hound Dog's* skin to reduce its radar reflectivity. The three-phase study involves the determination of the materials to be used, their application to the missile and, finally, testing of the materials' effectiveness.

## SUPPORT EQUIPMENT

### Concern Voiced Over Dry Deflector Talk

Engineers at NASA's Marshall Center are concerned with rumors emanating from Washington that “dry” deflectors are being considered for *Saturn*-type launch pads. The concern arises from the fact that considerable sound attenuation is achieved just by the deflector coolant water. Without the water, according to one engineer, the static tests of the *Saturn* would have broken every window in the headquarters building—approximately a mile from the static test stand.



# 'Theoretical Formability' Praised

**Cost-cutting concept described at AF-sponsored symposium; a report on other highlights of meeting**

by John F. Judge

PHOENIX, ARIZ.—A new concept—theoretical formability—is expected to save time, manpower, tooling, materials and dollars in the production of missile/space hardware.

It was described to over 1500 industry representatives at a Materials Symposium sponsored here by the Air Force's Aeronautical Systems Division.

Called by J. Bryars of ASD "one of the most significant pieces of work being accomplished today," the method is essentially a means of bridging the vast gap between theory and shop in metal fabrication.

Theoretical formability correlates a metal's properties and the processes involved in forming it. Thus, major stumbling blocks such as limited design data, redesigns, improper materials selection and costly scrappage are eliminated. The most acceptable material can be selected and, by analyzing the material properties, the correct forming process can be chosen the first time.

For an example, Bryars picked a part having geometries allowing fabrications by either drop hammer or mechanical die.

The first inclination is to choose the least expensive process. But the analysis might show the job outside the drop hammer's capability. The mechanical dies operation, though more expensive, would produce the part the first time. The analysis will also specify forming at elevated temperatures if this is necessary, thereby guiding selection of tools and tooling materials.

There is nothing mysterious about theoretical formability. It grew out of the cleavage between purely theoretical and practical experimental work.

• **Failure system** — Basically there are eight major steps in the development of formability equations. The procedure depends on a thorough understanding of the forming process so that the parts and processes can be analyzed and the failure types determined.

When the part geometries relating to the failures have been determined, general failure limiting equations can

be developed. The equation is next graphically portrayed and sample parts are selected and formed to empirically establish the curve's position. At this point a limiting curve for one process and material has been established and verified.

Means to relate the properties of one material to another are set up. These formability indices, once established and verified, can establish the position of curves for other materials. The last step is to finalize the equations into forms so that correlations between one material and another will be valid for selected geometrical and property parameters.

Once they have been performed, these steps need never be taken again for the process involved.

A current Air Force contract with Chance Vought Corp., Aeronautics Division, proves that the initial development of the formability limit equations and graphs were accurate.

Vought extended the concept to 12 separate forming processes and 19 aerospace metals. Not only are the graph shapes correct, but correlations show that the formability indices can predict the position of the graph for each material.

This means that materials properties obtained from simple tests can be used to predict formability limits.

Bryars says the work still has to be extended to all sheet-forming processes. The Vought work did not include some of the more complex shapes produced by several of the processes. Theoretical formability can be extended into the high-energy-rate-forming area, but a better understanding of these processes themselves would be needed.

• **High temperatures** — It also was pointed out to the meeting that the structural metals and refractories now being used in high-temperature applications have completely outstripped adhesives of equivalent heat-resistance. Current Air Force programs are targeted on developing such bonding materials; it is evident that organic adhesives

will not meet advancing requirements.

F. W. Kuhn, G. P. Peterson and R. C. Tomashot of ASD attribute this to three obvious facts.

—Commercial resin and adhesive manufacturers who contributed their skills, facilities, and capital to develop the first adhesives adopted for military use have failed to qualify a single adhesive under a now 6-year-old specification. The principal requirement of 1000 psi tensile lap-shear strength at 500°F after 192 hours exposure is in itself but a token target in comparison with existing and future requirements for stable bonding materials at temperatures upwards of 2500°F for longer periods of time.

—Although contractual programs for modifying organic adhesives with inorganic additions have succeeded in extending the 8-day thermal stability to 600°F, the resultant initial and elevated temperature strengths have been materially reduced.

—Although programs of basic research to synthesize new chemical type of thermally-stable organic resins specifically for use in structural metal-to-metal adhesives have succeeded to the extent of producing resins having in themselves high softening points (above 700°F), the adhesives produced have exhibited poor mechanical strength even to exposures of only 400°F.

The most fertile field for bonding materials seems to be in the ceramic adhesives area. Their main disadvantage, brittleness, is slowly giving way as research efforts continue.

• **Flash joints** — Another unique method for joining metals has recently been adapted to sandwich construction. The process is called the "Exo-flu Method." The prefix refers to an exothermic-reactant composition which when applied to, and ignited on, the external surfaces of the metal to be joined, imparts an intense heat of short duration. This flashing, imparted to metal oxide fluxing agent and elemental metal donating material which has been previously within the bondline, form

a strong adhesive joint with a continuous metal phase.

Under these conditions of firing, the metal oxide of the fluxing agent releases its metallic portion to form a eutectic with part of the base adherend metal. Kuhn and his associates say that no attempts have been made other than with stainless steels such as 17-7PH, PH15-7Mo, AM-350, AM-355, A-286, A-302, and A-321. The method promises to be adaptable to the bonding of higher-temperature alloys such as Inconel X and Rene 41.

A final significant point is that the method adds relatively negligible weight to a structure. It takes 0.006 lb. per square foot of Exo-flux compared to 0.3 lb. of standard average brazing alloy for the same area. Patents have been filed in the process.

Two other specialized adhesive areas were mentioned. One is the development of room-temperature curing agents for field work and the other covers cryogenic needs in adhesives. Organics hold promise in the latter.

• **Oxidation coatings** — N. M. Geyer of ASD finds the current refractory metal-coating technology somewhat disproportionate. A high degree of effort is still being devoted to optimization, scale-up and establishment of reliability for molybdenum coating for re-entry purposes. No single coating for columbium is as fully advanced as the pack-silicide coating formolybdenum, but at least three—the vacuum vapor Ti-Ti-Si alloy, the slurry aluminide and the pack-silicide—appear promising.

Tantalum coatings are comparatively new and unexplored. No coatings for tungsten have progressed far beyond

laboratory feasibility studies.

The standardization of coating evaluation procedures remains a major problem area. Geyer says this task should be relegated to design and applications engineers for testing against specific design requirements.

There is a continuing need, says the Air Force scientist, for related efforts in support of coating development. Since direct effort developments are made on a basis of meeting immediate requirements, it is probable that resulting coatings will suffer disadvantages necessitating design compromise.

These areas should include both investigations of feasibility of various application techniques to form classes of coating compositions and the development of alternate techniques to form specific proven compositions. The problems of ductility and self-healing should also be handled.

A wide spectrum of fundamental investigations is needed to support intelligent coatings studies. The mechanisms of oxidation in refractory metals and in the coating themselves, the nature and chemistry of oxidation products, and the deterioration of coatings by physical processes are weak points in current U.S. programs.

• **Electronics limited**—Further advances in electronics are highly dependent on materials technology, F. E. Wenger, Air Force Systems Command, told the symposium. He said the greatest current problem is the reliability of electronic equipment. Contemplated future military and space functions cannot be accomplished with equipment having mean time to failure of only 1000 hours.

This period must be extended from

10,000 to 100,000 hours. Since future electronic systems will be designed with functional blocks, any failure will be a materials failure, he said.

The long time requirement means that certain materials used in parts or subsystems must have failure rates less than 0.0001% per 1000 hours of operation. Wenger said the attainment of such reliability must be based on an understanding of the materials and processes involved. This is something entirely different from mere running of tests.

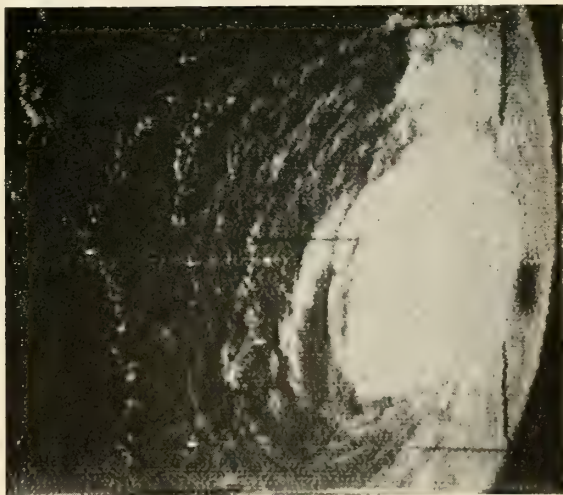
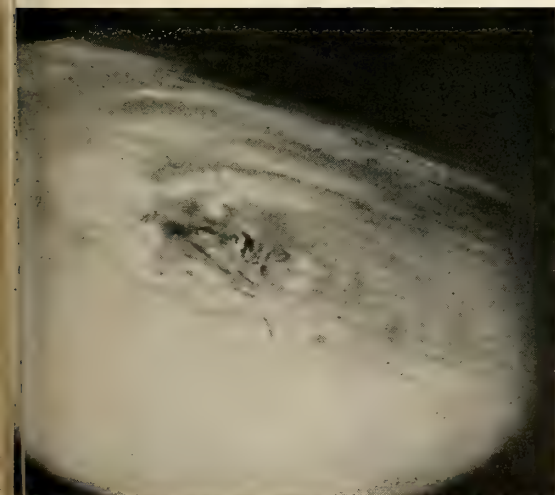
The materials specialist said the U.S. is becoming a nation of research followers rather than a nation of independent thinkers. Some of the vast research energy devoted to silicon and germanium in solid-state work should be funnelled into searching for new phenomena.

"It would appear that one of the payoff efforts would be to forget about electronic construction as we know it today, break down electronic functions into various phenomena such as generation, amplification, mixing, modulation, demodulations and display—and synthesize black-box electronic functions from physical processes," Wenger said.

Wenger maintains the problem of material for electrically transparent housings such as radomes has never been adequately solved. Basic work is a must on alloys that act as superconductors at normal temperatures without the basic materials being superconductive. Superconductors exhibiting magnetic properties are needed.

Flexible ceramics with high insulating resistance in the microwave area

(Continued on page 46)



## 'Debbie' Snapped Twice from Space

THE OF HURRICANE "DEBBIE" shown in photo taken from Mercury Atlas-4 spacecraft 12 minutes after it was launched on earth-orbit flight Sept. 13. MA-4 took about 360 photos.

EARLIER PICTURE of "Debbie" was taken by NASA's Tiros III weather satellite when storm, not yet of hurricane force, was 2500 miles east of Miami—25 degrees N, 42 degrees W.



# PRISM to Be Used on Missile Ships

*Maintenance management method, big success in gunfire control system, is efficient and flexible*

by William Beller

THE NAVY is introducing a new maintenance management concept aimed at ensuring constant readiness of the Fleet's weapon systems.

All ordnance systems on guided missile destroyers of the DDG-2 class—which carry *Tartars* and *ASROC's*—are being studied preliminary to installation of the concept, called "PRISM."

The idea was first tried out on the Navy's Mark 56 gunfire control system, and worked so well that it is now being tailored to fit the more modern Mark 68 system.

PRISM stands for "Programed In-

tegrated System Maintenance." (It is not related to a "reliability" concept which has the same acronym and is an offshoot of the management tool PERT.)

It is designed to arrange the bits and pieces of the maintenance jigsaw into a picture that management can recognize and work with. It can be used in any weapon system—and on commercial equipment—which requires periodic maintenance, and its devisers say that it rapidly becomes more useful as the maintenance problem becomes more complex.

Furthermore, PRISM lends itself to being expressed on a computer; managers at any level will be able to "read out" current capital-equipment readiness, in much the same way they can learn the status of a research and development effort through the computerized PERT. (M/R, July 17, p. 110).

Benefits of PRISM are said to be these:

- It identifies and keeps track of the maintenance jobs to be done.

- It recognizes immediately jobs that cannot be done with the facilities on hand.

- It clearly describes and standardizes maintenance jobs.

- It relates the maintenance job to the minimum skill needed to do it. In this way, highly skilled workers are made more freely available for work requiring their special abilities.

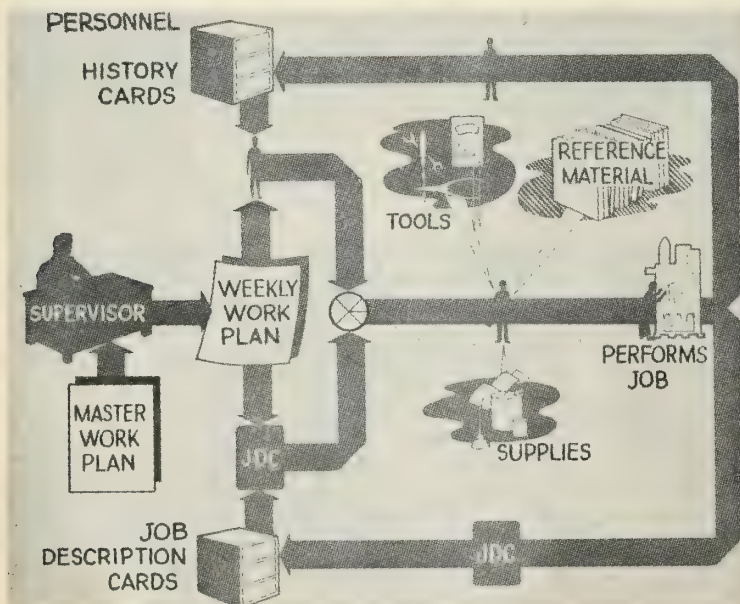
- It acts as a filter, straining out unimportant jobs. For example, shipboard personnel are not given maintenance jobs that do not contribute to the ship's mission.

- It makes paper work simple and economical—four records being all that are needed.

- It provides material for training programs; in fact, it is said to serve well for on-the-job training.

- **Antecedent** — The forerunner of PRISM was developed eight years ago aboard the USS Des Moines by Chief Fire Control Technician C. E. Satterwhite. Accordingly labeled "Satterwhite Method," it consisted of job description cards which outlined and scheduled shipboard maintenance operations. Later, the system was adopted by the Bureau of Ordnance for general use throughout the Fleet.

In 1958, the Satterwhite Method was enlarged into the comprehensive system now known as PRISM. The job was done by Jerome E. Levy, at his Washington Engineering Service Co., a Bethesda, Md. firm. Levy has been an employee of the Bureau of Ordnance, where he worked on many of the problems connected with shipboard



## How The Maintenance Loop Works

(1) The local supervisor consults the Master Work Plan, determines what tasks are to be performed during the calendar week, and lists these in his Weekly Work Plan. (2) The supervisor selects Job Description Cards for the particular tasks to be performed during that watch, day, or shift. (3) The supervisor consults the file of Personnel History Cards and assigns per-

sonnel. When personnel and JDC's are "married", tools and supplies may be selected, reference material examined if necessary, and the job performed. (4) Feedback after the job is performed is in two patterns: The performance is noted on the Job History Card as the JDC is returned to file; the performance by personnel is noted on appropriate Personnel History Card.

re-control performance and maintenance.

Levy's company is now heading the military-industry team developing PRISM for DDG vessels.

At a recent Fleet Maintenance Conference in Norfolk, a representative of the Chief of the Bureau of Naval Weapons said that PRISM not only provides maintenance that fits operational requirements but also "provides maintenance oriented to the needs of the machine dictated by its design, and the needs dictated by the mission."

He also said that "PRISM for the DDG will integrate existing Satterwhite coverage into a comprehensive plan which will include all DDG ordnance systems." One of the sparkplugs in bringing this about is E. L. Meehan, the Bureau's Chief Maintenance Engineer.

In general, PRISM calls for (1) an appraisal of the maintenance work that is to be done to fulfill a mission; (2) an examination and description of how the work is to be done; (3) an organized approach to doing it; and (4) a constantly current report on the maintenance readiness of all capital equipment.

• **How PRISM works**—The basic PRISM loop is illustrated in the accompanying chart.

The *Job Description Card (JDC)* is fundamental. Made of a tough plastic that it will not wear out when returned to on the job, this card contains all the information a man needs in order to do his maintenance chore. Moreover, it calls for one of three grades of maintenance skill, starting with that possessed by the relatively inexperienced man.

Information for the JDC cards is obtained by professional maintenance men who study the maintenance problem, interview manufacturers and others concerned with the equipment, and watch the various maintenance jobs being done. On-the-spot pictures are taken with a Polaroid camera. These illustrate the maintenance job and add a realism and practical approach that is difficult to get with the usual engineering drawing or isometric.

The JDC's are one of four records comprising PRISM. The others are the *Personnel History Card*, the *Weekly Work Plan*, and the *Personnel History Card*.

Every Job Description is mated with a *Job History Card*. Accordingly, each *Job History Card* tells the state of maintenance of a piece of equipment.

Once a week the man who assigns the work enters on the card the date (the week beginning), the interval at which the job is performed, the name of the man assigned to the job, whether or not he has previously been qualified,

pertinent remarks (particularly if a casualty was discovered), and his initials to verify that the job has been completed for the week.

A Master Work Plan appears in front of each set of Job Description Cards covering a particular weapons system. The Master Work Plan lists by JDC number and, by weeks, the schedule for performance of the maintenance jobs for each of the 52 weeks of the year. In addition, a *Weekly Work Plan* is made up and posted to inform all hands of the maintenance jobs they are to perform during the week.

Lastly, there is the *Personnel History Card*. This tells what jobs a maintenance man has done, how well he qualified for them, and thus whether he is qualified for more difficult and varied assignments.

• **Highly adaptable**—The PRISM system has sufficient flexibility to adapt itself to changing conditions. For the Navy, for example, PRISM offers a convenient way to catch up on maintenance work after an enforced layoff due to weather, shore leaves or wartime activities.

A similar situation might arise in industrial plants that have been closed or running slack because of a company-wide vacation, strikes, or seasonal variations in employment.

In such instances, when normal operation is resumed, the first Weekly Work Plan is taken from the week that appears on the Master Plan immediately after the last week that was worked. That is, if there was an enforced layoff for three weeks after the work in the 14th week in the Master Plan had been performed, the first week's work after resumption should be based on the 15th week on the Master Plan and not on the 18th week. In this way, no annual, semiannual or monthly jobs will be neglected.

When a short week occurs, and not all the jobs scheduled for the week are performed, the annual, semiannual and monthly jobs are carried over to the next week.

PRISM is not an automated panacea for the problems of maintenance management. This is emphasized by Levy and many of the men connected with the concept. "PRISM," they say, "does not provide for its own adoption." This must be done by managers seriously interested in an organized maintenance program.

Furthermore, once PRISM is instituted it must be kept up to date by the people doing the maintenance work, the work sheets must be carefully prepared and constantly monitored by the managers, and maintenance "exceptions" must eventually be brought into the fold. ■

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# Houston Lab to Be Complete in '64

## **NASA's Space Task Force to move in after Mercury orbital series is over; Gilruth is possible choice for director**

NASA's \$60-million Manned Space Flight Laboratory, to be located in Houston, Tex., is scheduled for completion in late 1964—well in advance of major flights in the *Apollo* program.

Space Agency officials report that some of the major buildings at the site will be completed within 18 months, with construction of the others expected to take from 26 to 36 months. Announcement of the location was made last week.

The laboratory, located on 1000 acres of land made available by Rice University in Harris County, will be the command center for the U.S. manned lunar landing mission and all follow-on manned space flight missions. It will be utilized to design, develop, evaluate and test the *Apollo* spacecraft and its subsystems, as well as to train the crew for the missions.

NASA's Space Task Group, currently located at Langley, Va., will move to the new facility as soon as the *Mercury* orbital flight series is completed. While no announcement has been made, it is expected that Dr. Robert C. Gilruth, current director of the Space Task Group, will head the new laboratory.

NASA has funds in its Fiscal '62 budget for the development of the site and the construction of four integrated facilities: a flight project facility, an equipment evaluation laboratory, a flight operations facility, and an environmental testing laboratory. NASA officials report that more funds for expansion of the center will be requested in the Fiscal '63 budget and that further expansion will take place to meet the need for very large vehicles for interplanetary exploration.

A breakdown of the four facilities in the laboratory follows:

• **Flight Project Building**—To house the executive offices, project engineering offices, flight systems offices, and central management services, an eight-story, \$12,000,000 facility is planned. The building—providing approximately

340,000 square feet of space—will serve as the management, engineering and service center for the Manned Space Flight Laboratory.

In addition, a scientific library, central reproduction facilities and the centralized computing and data systems will be located in this building. Conference and briefing areas will be provided for staff meetings and briefings of contractors, scientists and military personnel involved in the project. A fallout shelter is also included.

• **Equipment Evaluation Lab**—The Equipment Evaluation Laboratory and Support Facility provides the central services complex, including the shop and assembly areas for the preparation and repair of *Apollo* models and other equipment. The proposed buildings will be of standard mill-type construction, with offices convenient to the shop and laboratory areas.

In the equipment evaluation laboratories, capabilities and performance characteristics of the components and systems will be thoroughly tested to insure the high reliability required for manned space flight.

Also housed in this facility will be the maintenance facilities, procurement and supply activities including a stockroom, shipping, receiving, and warehouse areas and budget and finance activities.

To cost some \$13.2 million, the facilities will provide approximately 142,000 sq. ft. of offices—64,000 for shop and assembly bays and 64,000 for the equipment evaluation laboratory.

• **Flight Operations Facility**—Consisting of a three-floor, 50,000-sq.-ft. office section abutting the laboratory and training facility area of approximately 70,000 sq. ft., the \$3.6-million Flight Operations Facility provides an integrated center for the required mission simulation, as well as training equipment for the flight operations and training groups.

Part of the laboratory area will comprise a flexible arrangement of components for mission simulation. Among these will be:

—A display of the navigational environment to the navigation systems and components and/or pilot in either inertial or vehicle coordinates through the arrangement of suitable optical projections and screens.

—A test platform in the navigation environment capable of large-angle low friction motions.

—A test chamber in which machine relationships would be evaluated in the internal environment of a space capsule.

—Function generators and associated apparatus for appropriate synthesis of vehicle, system and/or trajectory parameters, for the control of field and platform motions and for integration of the motion, field equipment and man-machine elements into a dynamic simulation of the flight mission.

—Instrumentation, data-handling devices and associated apparatus for general support of navigation and control tests.

These training facilities, however, will be supplemented later with training devices more closely oriented to the manned flight mission.

To aid in evaluation of space navigation techniques and components, a navigation and control dynamics simulator will be built. It will provide a means for evaluation of the requirements and performance of navigation, stabilization and control systems and components.

A simulator of this type allows effective evaluation of the man-machine relationships essential for the lunar landing mission.

• **Environmental Testing Laboratory**—Facilities for testing the full-size *Apollo* spacecraft under critical in-flight environmental stresses will be provided in this testing complex. The main section of the building—a 100,000-sq.-ft. area—will provide for orderly spacecraft preparation, instrumentation, environmental testing and data handling. Adjoining the lab will be a two-story 30,000-sq.-ft. office area and a submerged test cell of approximately 400 sq. ft.

Within the laboratory area, two large thermal-vacuum chambers will subject the *Apollo* modules and assemblages to the pressure and temperature environment of space.

The first cell—100 feet in diameter and capable of handling the complete *Apollo* vehicle with extended antennas and solar arrays on a gimbaled mounting system—will permit manned operation of the spacecraft under test. The

chamber's design includes pumping facilities to permit evacuation to  $0^{-5}$  mm of Hg within 24 hours, sufficient capacity for operational test periods of about 500 hours, solar heat radiation simulation of 130 watts per square foot over a 50-ft.-diameter circle, and temperature control to simulate space temperatures and the planetary albedo.

The second chamber will be closely integrated with the first to provide maximum use of common support equipment. Approximately 60 feet in diameter, this cell will accommodate the spacecraft modules with space simulation capabilities paralleling those of the larger chamber. Due to its smaller size, however, it will allow better simulation of ascent pressure changes and attainment of high vacuum in a shorter period of time.

• **Ancillary Testing Equipment**—Also included in this facility will be the control centers for monitoring and effectively operating the thermal-vacuum chambers and the data-handling equipment associated with them. Other support equipment located in the laboratory will be:

—An arrangement of backstops, tie-down points and loading and load distribution apparatus for static loading tests.

—A centrifuge for inertial loading tests.

—A scaled group of shakers with complex wave-drive systems for dynamic loading tests.

—Shock and impact test apparatus, as well as sound generators controlled by the shaker drive systems, to permit environmental testing of spacecraft structures in the high acoustical fields associated with the boost phase of launching.

—Quartz tube-type heating elements with a programed control system to permit spacecraft structural evaluation in high-temperature environment.

—Test instrumentation (data-handling apparatus and related auxiliary equipment) to support test programs.

The overall cost of this facility is expected to be \$26,482,000.

• **Site Improvement**—NASA has allotted a little over \$4.5 million for site development and utility installations. This includes clearing and grading, a public road system, security fencing and street lighting, and an electrical power system.

The latter would be composed of a substation and distribution lines for 20,000 kva backed up by a 1000-kva emergency motor generator station, a central heating plant and chilled water and air-conditioning system, a sanitary sewer and storm drainage system. ■

## IBM Chosen to Build Thin-Film Production Line

FIRST SERIOUS attempt to develop an automated high-volume production line for thin-film subassemblies will be made by International Business Machines Corp.

The Navy announced last week the award of a \$506,861 contract to IBM's Federal Systems Division to develop and build one pilot production line capable of continuous vacuum deposition. The production goal, using wafer substrates, will be to achieve a rate of over 200 square inches of thin-film electronics subassemblies per hour.

Work will be performed at Federal Systems' Command Control Center, Kingston, N. Y. With its own funds, the company also will build a duplicate production line to further advance its in-house thin-film R&D effort.

Technical guidance for the one-year program will be provided by the Bureau of Naval Weapons, Naval Avionics Facility (NAFI), Indianapolis, Ind.

• **The need is urgent**—As evidenced by the unusual coverage given this field by the trade press over the past several years, there is an urgent need for making electronic systems more reliable and rugged and at the same time reducing their size, weight and power. With system complexity has come burdensome size and intolerable power and cooling requirements.

The move to solid-state systems was the first successful frontal attack on the problems.

The broad use of thin-film circuits, providing even more reduction in power needs and at least a magnitude increase in parts-density capability, is widely believed to be the next logical step toward solution of the industry's design troubles.

Even with the advent of truly functional circuits or subsystems, scientists say, thin-film subassemblies will complement their use as supporting building blocks for next-generation electronic systems.

• **IBM's approach**—In the fabrication of thin-film components, various materials—each chosen because of its particular electrical properties—are vaporized by heat in a vacuum container.

In turn, each vaporized material is deposited through a mask or stencil carefully fitted over a base or substrate. Thus, a complete thin-film

subassembly can be built up in layers by precisely controlling deposit location, sequence, shape, and thickness.

By properly arranging conducting and non-conducting materials and integrating these with appropriate semiconductors, conventional electronic functions can be performed.

The IBM-NAFI problem will be to design and integrate the deposition equipment, controls, and monitors necessary to move present technology from the laboratory to the production facility.

IBM has indicated that it will employ a fully automatic line composed of four vacuum chambers, with access to each provided by airlocks. A transport mechanism will carry substrates from chamber to chamber.

Substrates will be masked automatically in the furnaces; temperature and time will be controlled accurately throughout the deposition period. The process continues in each chamber until all the required layers have been made.

For batch fabrication, the chambers can be separated.

To achieve high standards of purity, reproducibility and parts uniformity, IBM says, a chemically-inert high-vacuum process will be used.

• **Mandatory use someday?**—The Navy says the new facility will be used to evaluate thin-film technology. It may also lead to a requirement that such techniques be used in the future for Navy electronic components and systems.

Following successful completion of the program, the Navy says, it will encourage other manufacturers to install similar production lines as part of its (BuWeps) industrial readiness plan.

IBM said it will either market the thin-film production equipment or establish one or more sources for marketing and fabrication of the system.

NAFI plans to use the equipment to produce thin-film devices for use in highly advanced experimental electronic equipment. These will include missile guidance systems, satellite instrumentation, data processing equipment and communications systems. It is with these devices, said Navy, that savings in weight, volume, and power are extremely vital.





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## WEAPON SYSTEMS SPECIALTIES

BETTER THINGS FOR BETTER LIVING... THROUGH CHEMISTRY

## Materials Symposium

(Continued from page 1)

would be a worthwhile project, according to Wenger. There is a desire for specialized materials for specific application which do not need doping.

The day of the simple glass-enclosed electron tube is nearly over. The tubes of Air Force interest are practically complete electronic subsystems needing in most cases only a power supply and an antenna.

Many tubes require external magnetic elements to control the path of electrons flowing within the tube. Wenger lists some of the requirements:

- Coercive force: The need is for a constant or nearly constant coercive force versus temperature curve.

- Nuclear radiation: Most high-coercive-strength material contains cobalt, which has a long half-life. The need here is for a material which does not retain radioactive properties after exposure.

- Periodic focusing: The Alnico series so far have not been usable for periodic focusing of traveling wave tubes. Ferrites have been used extensively. The need is for a lightweight material with Alnico's flat coercive force versus temperature characteristic and the ferrite's machinability and ability to retain magnetic field under shock and vibration.

Other tube problem areas outlined by Wenger include:

- Study of high-strength metal whiskers for storage screen mesh image tubes.

- Study of high-strength dielectric material whiskers for storage mesh memory tubes.

- Study of Electrets for memory tubes.

- Study of single crystal selenium and other possible materials of high resistive properties for EBIC Camera Tubes.

- Study of secondary emitting properties of materials used in imaging memory tubes.

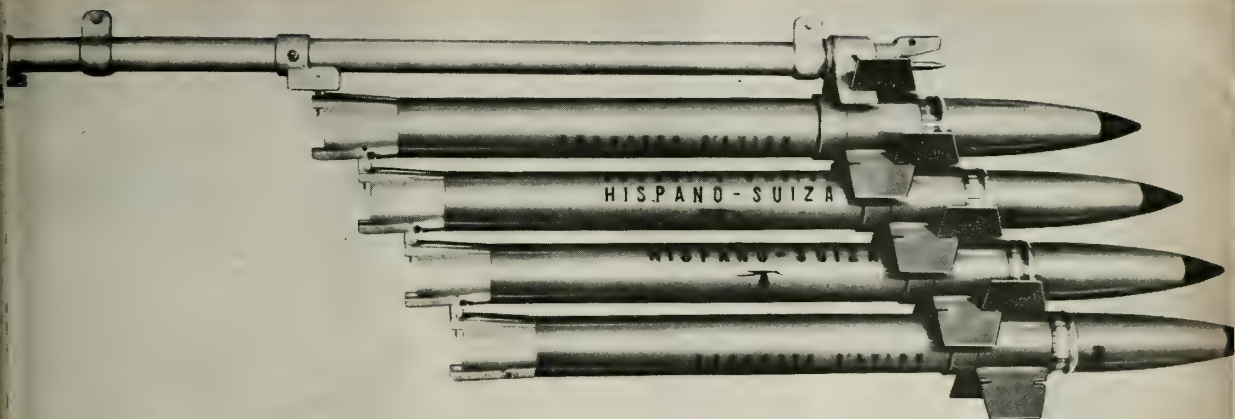
- Study of photo emission.

- Study of electron bombardment induced conductivity in dielectric materials for imaging and memory tubes.

- Study of material photo-emission in visual octave and photo-conductivity to the infrared octave of the electromagnetic spectrum.

- Search for anisotropic resistive material for use in image storage targets.

- Search for anisotropic materials as a substitute for fiber optics and as a substrate for photo sensitive-phosphor screens used in image amplifier tubes.



NATO LAUNCHER equipped with Sura suspension devices. Simplest arrangement is stacking in tiers.

International

## Swiss Rockets Fit NATO Launchers

*Hispano-Suiza's Sura series has simple suspension arrangements for Mach 1 planes supporting troops*

by Bernard Poirier

AIR-LAUNCHED ROCKETS, the requisites for ground troop support, have been adapted by most European manufacturers to fit the NATO launcher first and their own systems second. The Sura rocket series by Hispano-Suiza of Switzerland is no exception.

The 3.15-in. solid Sura R80-A is fitted with 12-in. fins which slide along most of the rocket's 43.2-in. frame. A standard 23.1-lb. Sura carries a 4-lb. warhead including a 2.2-lb. explosive charge. A hollow charge is also available.

For practice firings, both the smoke charge and the dummy head have the same ballistic properties as the standard war-rocket. From an aircraft flying at 497 mph, a 50% height and width dispersion of about 10 milliradians is obtained.

When the rockets are fired from a ground test ramp, however, dispersion is slightly increased because of the absence of aerodynamic stabilization.

Propellant ignition is triggered in 1 sec. under 2.5 amperes. A normal voltage of 24 volts dc and internal 3 ohm resistance of the motor gives

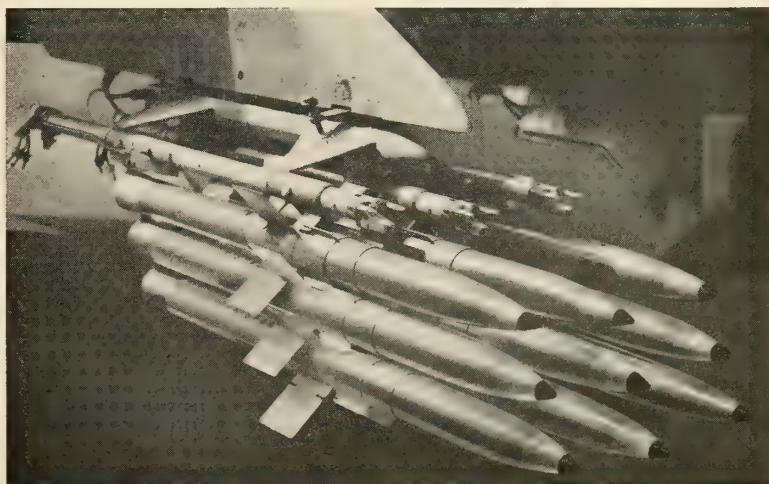
greater current. At 15°C, combustion duration is .6 sec. with interior pressure of 418 lbs/cm<sup>2</sup>. Combustion temperature is rated as 3000°C and thrust at 2640 lbs.

An increase in initial temperature, producing higher pressure and thrust, shortens combustion time. A temperature decrease has an opposite effect, although the impulse suffers no significant change—its value remaining around 1540 lbs./sec. Best functional temperature range is -40°C and +50°C.

Rockets are carried and fired ac-

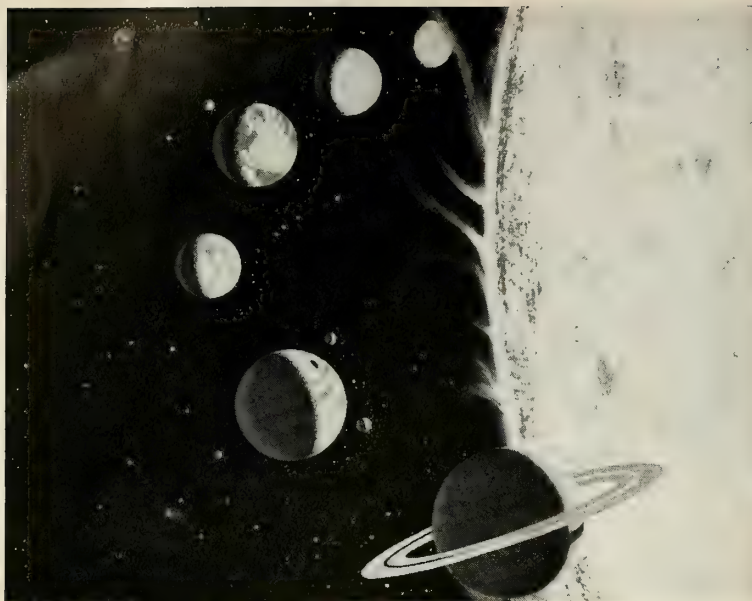
cording to the aircraft's design. Most commonly, they are hung under the wing in the open, fitted in containers under the wing, or fitted in the fuselage. The simplest European suspension stacks one rocket below another in tiers.

• **Simple style**—One Hispano-Suiza (Suisse) design requires no wires and no launcher, and has only two fittings attached directly to the wing to accommodate the top Sura rocket. The sliding fins serve as front suspension element prior to firing. The rocket frame then slides through the fins until the motor



HISPANO-SUIZA'S Type R-80 Sura aircraft rockets on Fiat G-91 attack fighters, a Mach 1 aircraft. Mach 2 planes require rocket containers and folding rockets.





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**ATMOSPHERIC FLIGHT TRAJECTORY ANALYSTS** To determine flight performance and control characteristics for all phases of earthbound flight. Missions to be analyzed include ballistic flight, cruise in atmosphere, and recoverable boosters, but major emphasis will be on techniques of re-entry. Familiarity with analog and/or digital techniques is desirable. Openings exist at all levels.

**FLIGHT CONTROL ANALYSTS** To conduct research programs in new techniques of controlling large aero-elastic airframes and manned re-entry flight vehicles. To develop accurate and efficient attitude control system concepts for spacecraft. To determine automatic control system requirements integrated with airframe, propulsion system, and man in the loop. Openings exist at all levels.

**NUMERICAL ANALYSIS AND DIGITAL PROGRAMMING** Engineers required who are familiar with one of the above problem areas and who desire to take intensive training in FORTRAN digital programming. Mathematicians required to perform numerical analysis studies leading to optimum problem solution techniques by digital means. IBM 7090 available, also smaller computers for personal experimentation.

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**SPACE & INFORMATION SYSTEMS DIVISION**  
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tube picks them up at the conical end where they remain as stabilizers.

Rear suspension is provided by a flap on the high rocket which also fixes the one below. On firing, the exhaust opens the retaining device and blows the flap into the recess of the upper rocket. This action transfers the ignition circuit automatically to the next rocket above.

This Hispano-Suiza design adapts easily to the NATO launcher where standardization is demanded for use in the Mach 1 range, such as with the NATO Fiat G-91 attack fighter.

Mach 2 aircraft require rocket containers to cope with resistance and drift within standards of stiffness. Folding rockets are used with such containers. Hispano-Suiza has the *Lesca* series compete with offerings of Hotchkiss, Brandt, Bofors, Oerlikon and others.

Effective close-in support of ground troops is better served by the slower class aircraft. To raise probabilities of greater accuracy, Hispano-Suiza has promised in favor of velocity over payload; the resulting higher speed increases accuracy and cut flight time again. Tanks, armored cars and other moving objects.

The Swiss company points out that unguided rocket tests have demonstrated that, despite advances in guided missiles, suitably designed free-flight rockets still provide one of the best methods of close-in support.

These rockets, fired in bursts of several birds, give a high rate of kill per dollar invested and are not likely to be replaced, Hispano-Suiza maintains, by guidance sophistication developed for other tactical maneuvers.

## U.S., British Join in New Radio Satellite Test Work

THE U.S. AND BRITAIN will cooperate in further tests of radio communication by satellite.

An agreement by the British Post Office, the National Aeronautics and Space Administration and the American Telephone and Telegraph Co. calls for U.S. launching of a satellite next year to transmit speech and television from Rumford, Maine, to a receiving station being built by the British at Goonhilly Downs, The Lizard, Cornwall.

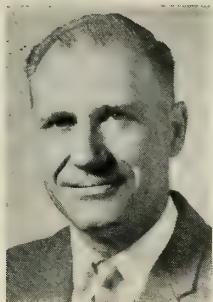
The test program, named TSX, will study the possibility of using satellites for continuous 24-hour phone and telegraph service, and worldwide coverage in combination with existing radio and cable links. The satellites, which may carry 1000 telephone channels and one or two TV channels, would use higher frequency bands than the *Relay* satellites.

The test satellite will be controlled from the U.S.

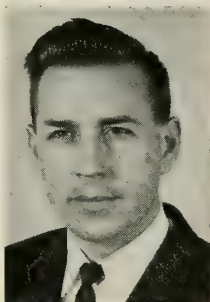
# names in the news



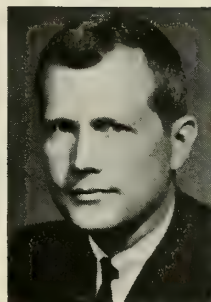
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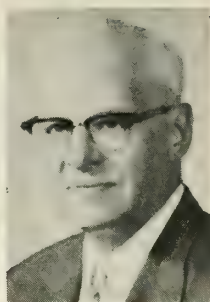
WAMBSGANS



SAMSON



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INGERSOLL

**Dr. J. A. Rajchman:** Pioneer in computer research, appointed director, Computer Research Laboratory, Radio Corporation of America's David Sarnoff Research Center, Princeton, N.J. Other RCA appointments are: **Charles A. Daly, Jr.**, manager, Small Business Affairs; **Edwin McCollister**, division vice president, Marketing, Electronic Data Processing; and **James Lee Owings**, manager, Engineering, Data Communications and Customs Projects Dept., Electronic Data Processing Division.

**George C. Dacey:** Director of Solid State Electronics Research, Bell Telephone Laboratories, will become vice president, Sandia Corp., Albuquerque, N.M., on Oct. 16. Dacey succeeds **Calvin Quate**, who has accepted the position of Professor of Applied Physics and Electrical Engineering, Stanford University.

**Sidney Thurston:** Veteran marine propulsion engineer, named manager of Hydropower Div., Astropower, Inc., Costa Mesa, Calif., a subsidiary of Douglas Aircraft Co.

**Philip B. Taylor:** Former Assistant Secretary of the Air Force for Materiel, elected to the board of directors, General Decision Equipment Corp., Tarrytown, N.Y. **George T. Mundorff** appointed administrative assistant to **R. E. Hastings**, Librascope Div. vice president and manager of General Precision's Burbank, Calif., plant. Mundorff transferred to Librascope from GP headquarters, where he was manager of corporate systems and procedures.

**Dr. Bernard Friedland:** Appointed senior staff consultant, and **Steven M. Sisman**, head of Communications Theory Laboratory, Melpar's Applied Science Div., Watertown, Mass.

**Dr. Bernard Wambsganss:** Appointed assistant to president, Alfred Electronics Corp., Palo Alto, Calif. Before joining Alfred, Dr. Wambsganss was chief scientist of the Office of Naval Research Branch Office, San Francisco, and also with Sylva Electronics Defense Laboratories.

**Clifford E. Willis:** Appointed vice president of operations, Avien, Inc., Woodside, N.Y.

**Lawrence Weeks:** Former engineering manager, McDonnell Aircraft Corp., joins Aerospace Corp., Los Angeles. **C. Ray Porter** named manager of Aerospace Corp.'s New England Office, Lexington, Mass.

**Melvin J. Albon:** Formerly with Aerojet-General Corp. and Reaction Motors, Inc., joins The Marquardt Corp. as chief metallurgist at the Van Nuys, Calif., plant.

**C. R. Possell:** Named chief engineer, Assembly Engineers, Inc., Los Angeles. Formerly Possell was president and chief engineer, Propulsion Development Laboratories.

**Capt. Joseph Garrett, USN:** Former Air Warfare Officer, Office of Naval Research, Washington, D.C., and Plans Coordination Officer, Pacific Missile Range, assigned to PMR headquarters as Range Operations Officer. Capt. Garrett relieves **Capt. Frank L. DeLorenzo, USN**, who assumes command of the USS Kennebec in the Atlantic Fleet.

**Dr. Charles M. Herzfeld:** Appointed associate director, National Bureau of Standards, Washington, D.C. With the Bureau since 1955, he will continue as Acting Chief of the Heat Division until a new chief is appointed.

**Edward Bishop, Jr.,** Treasurer; **H. Kenneth Hudson**, general sales manager, Military Div.; **William F. Frankart**, director of engineering; **John C. Mathews**, director of purchasing; and **Frederick Trowbridge**, director of quality control; elected vice presidents, The Hallicrafters Co., Chicago.

**Calvin A. Gongwer:** With Aerojet-General since 1945 and manager of its Oceanics Div., named vice president, Special Projects, Global Marine Exploration Co., in which Aerojet recently purchased a 45% interest with a view of expanding its oceanic activities and exploration. Gongwer participated in the development of the Alclo solid propellant, the invention

of the Hydrocket, and is a co-inventor of the MiniSub.

**Dr. James A. R. Samson:** Research physicist who recently established a vacuum ultraviolet laboratory at Harvard University to develop satellite spectrometers for solar ultraviolet research, joins the staff of the Geophysics Corp. of America, Bedford, Mass.

**Alfred J. Pote:** Former vice president, Itek Corp., elected senior vice president and assistant to the president, Page Communications Engineers, Inc., a subsidiary of Northrop Corp., Washington, D.C.

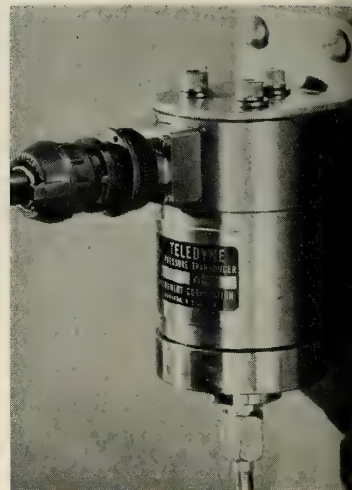
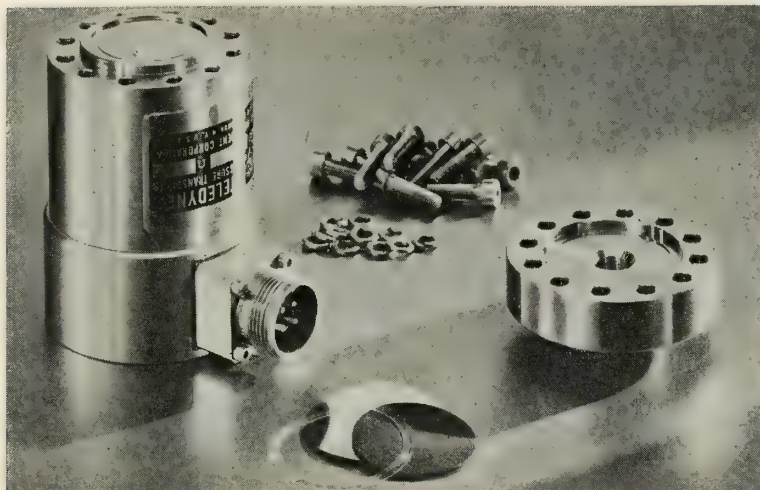
**Dr. Alfred Schneider:** Joins The Martin Co., Baltimore, as manager of fuel development; **Justin L. Bloom**, named manager of process development and **Meyer Pobereskin**, manager of isotope production. All are new positions in the Nuclear Chemistry Dept. in support of the company's program to step up development of fuels for SNAP atomic generators.

**Dr. Earl W. Lindveit:** Former staff member of the U.S. Senate Space Committee, appointed Washington representative for the Defense Systems Division of General Motors Corp. Dr. Lindveit is the author of the U.S. Senate reports on Project Mercury and "Space Research in the Life Sciences" and the book "Scientists in Government" published last year.

**Walter J. Schafer:** Former manager of space vehicle engineering, Missile and Space Vehicle Dept., General Electric Co., appointed director of engineering, Aircraft Missiles Div., Fairchild Stratos Corp., Hagerstown, Md.

**Roy C. Ingersoll:** Retires as chairman of the board, Borg-Warner Corp., Chicago, on Sept. 30, bringing to a close an active business career of more than 53 years. He will be honorary chairman of the board and also continue as a director. **Robert S. Ingersoll**, president of Borg-Warner, elected chairman of the board and chief executive officer, effective Oct. 1. **Lester G. Porter**, now executive vice president, named to succeed Robert S. Ingersoll as president on the same date.





## New Product of the Week: Taber's Transducer

An easily-maintained rapid-response pressure transducer is now available from Taber Instrument Corporation. A newly improved version of its Teledyne Model 176, the 3-lb. instrument has pressure ranges from 0-300 to 0-10,000 psig and may be operated continuously in the temperature range of  $-65^{\circ}$  to  $250^{\circ}\text{F}$ .

Its high-frequency response, says

Taber, makes it unusually suitable for measuring dynamic pressures encountered in the testing of rocket, jet, or turbine engines; hydraulic systems; and high-speed chemical reactions.

A stainless-steel cavity, diaphragm, and seal permit measurement of highly caustic liquids and provide positive protection for the electrical measuring element from the media in the cavity.

Circle No. 225 on Subscriber Service Card

Four precision strain gages, bonded to the inner and outer circumferences of a positive proving ring, comprise the measuring element. Linearity deviation of output signals, says Taber, is less than 0.25% of full scale from a standard straight-line function determined by the Least Squares Method. Units may be used with either a constant-voltage or constant-current system.

## Frictionless Motors

A motor which will run indefinitely, never needs oiling, can spin 5000 times in the flick of an eyelid, and works equally well in extreme low and high temperatures will be available from IMC Magnetics Corp.

The motor's secret lies in its air bearings—the surfaces on which the motor shaft rotates. Pressurized air cushions the shaft and allows it to spin with almost no friction. Air-bearing motors can operate at temperatures where the oil in conventional motors would freeze or burn up.

Circle No. 226 on Subscriber Service Card

## Axial Lead Power Resistor

Ward Leonard Electric Co. is marketing four additions to its Axiohm power-resistor line engineered for automation, printed circuits and advanced miniaturization use.

These miniature power resistors are intended for electronic applications where high stability coupled with high

overload capacity of vitreous enamel wire-wound power resistors is essential to reliable performance.

The new 2, 4, 7 and 12.5 watt resistors plus the former 3, 5 and 10 watt units make seven sizes available to electronic design engineers. Watt ratings for all sizes are based on a  $325^{\circ}\text{C}$  rise,  $25^{\circ}\text{C}$  ambient. Design changes also have been made in the 5- and 10-watt units, reducing their size by approximately 25%.

Circle No. 227 on Subscriber Service Card

## Silicon RF Mixer Diodes

Eighty high-reliability silicon RF mixer diodes for extremely low-noise mixer performance through 10,000 mc are available in two cartridge case types from Microwave Associates, Inc.

The fixed base cartridge series (MA-449B through MA-449F) directly replaces EIA types IN21B through IN21F. Reversed polarity diodes, MA-449BR through MA-449FR are also available. The reversible polarity equiv-

alent types in double-ended cartridge with detachable base adapter (MA-459B through MA-459F) directly replace EIA types IN416B through IN416F.

The calculated overall noise figure for the MA-449F and MA-459F is 1.5 db (max.) for 30 mc IF noise of 1.5 db. The new types are designed for 1500 operation and are hermetically sealed using an exclusive metal-to-ceramic solder-seal and solder-end seal construction for highest reliability. They provide applicable military environmental specifications MIL-S-19500.

Circle No. 228 on Subscriber Service Card

## Cryogenic Thermometer

Radiation Research Corp. is producing a cryogenic thermometer type CG-1 for use in the accurate measurement of temperatures in the liquid helium range of 1.5 to  $5.0^{\circ}\text{K}$ .

The subminiature hermetically sealed units, less than 0.350 in. long by 0.1 in. diameter, weigh less than 0.5

each and can be easily located in the most difficult and inaccessible spots for more accurate temperature measurement than is attainable by any other means commercially available for the indicated use range.

The type CG-1 thermometer now has accuracy and repeatability of considerably better than  $\pm 0.050^{\circ}\text{K}$ ; improvement to  $\pm 0.001^{\circ}\text{K}$  is expected.

Circle No. 229 on Subscriber Service Card

## Low-Cost Ohmmeter

The NLS 784 precision digital ohmmeter with printout connection has been introduced by Non-Linear Systems, Inc. The 784 has been designed for accuracy, reliability and simplicity of operation. It is fully automatic, with automatic range changing, positioning of the decimal point, and built-in controls for automatic operation of data printers. For trouble-shooting and servicing ease, the NLS 784 features NLS plug-in stepping switches, decade resistors mounted on plug-in circuit boards, and a snap-out readout to permit changing readout lamps in less than one minute.

Circle No. 230 on Subscriber Service Card

## Sweep Generator

A sweep-signal generator with interchangeable plug-in type oscillators covering frequency ranges of audio to 3000 mc is available from Telonic Industries Inc. Designated Telonic Model MS-1000, the generator accepts any of 19



different Telonic oscillator heads.

Construction is of the mil-slotted type, allowing quick, convenient range-changing with only one basic instrument. The various plug-in heads available include the E series with outputs covering the higher frequencies from 100 to 3000 mc, the S series for mid-range, 5 to 1200 mc, the L series for the lower frequencies from 10 kc to 25 mc, and the A series covering the audio frequencies.

Circle No. 231 on Subscriber Service Card

## Single-Sideband Strip Receiver

The Hallicrafters Co. has available an integrated multi-channel, single-sideband (SSB) communications system for the high-frequency spectrum that makes full advantages of SSB operation

readily available for commercial and military applications—stationary, vehicular, airborne or shipboard. Compared to AM systems, the Hallicrafters 116 series of SSB equipment offers a 2-to-1 advantage in spectrum utilization with greater frequency stability, requires 12 to 16 db less radiated power for equal performance, is far less affected by selective fading and phase distortion and, having only half the bandwidth, is less subject to narrow-band man-made interference.

Circle No. 232 on Subscriber Service Card

## Tuning-Fork Standard

Miniature tuning-fork frequency standards, which at audio frequencies approach the precision and stability of crystal oscillators, are available from Special Products Div. of Melpar, Inc.

The frequency standard is a transistorized electro-mechanical oscillator designed for systems which require a precise audio frequency sine wave or square wave for reference, measurements, time bases, and marker or clock pulses.

This design, which Melpar considers revolutionary, consists of the tuning fork and associated amplifier-oscillator printed circuit board, both enclosed in a small hermetically sealed evacuated case (MIL-T-27 Type AH) 1-17/64 x 1-17/64 x 1-3/4 in., weighing less than 2.9 oz.

Circle No. 233 on Subscriber Service Card

## Photoconductive Cell

A miniature photoconductive cell which approximates the spectral perception of the human eye more closely than any other device is available from Clairex Corp. This cadmium-sulphide cell can measure either tungsten or daylight over a wide range of color temperatures through variation in its conductance. The I series will contain six distinct types designed for both normal and low-impedance transistor type applications in both side- and end-view hermetically sealed configurations.

Circle No. 234 on Subscriber Service Card

## D-c/D-c Converters

A line of miniature, high-voltage, plug-in converters—especially designed for use in or with nucleonic instruments, photo multipliers, cathode ray tubes, and high-altitude research instruments—has been introduced by Universal Transistor Products Corp. Eleven models in four series are immediately available from stock, offering a wide range of input-output voltage combinations, adjustable or regulated. Outputs range from 500v to 5000 d-c, with inputs varying from 1.25v to 28v d-c.

Circle No. 235 on Subscriber Service Card



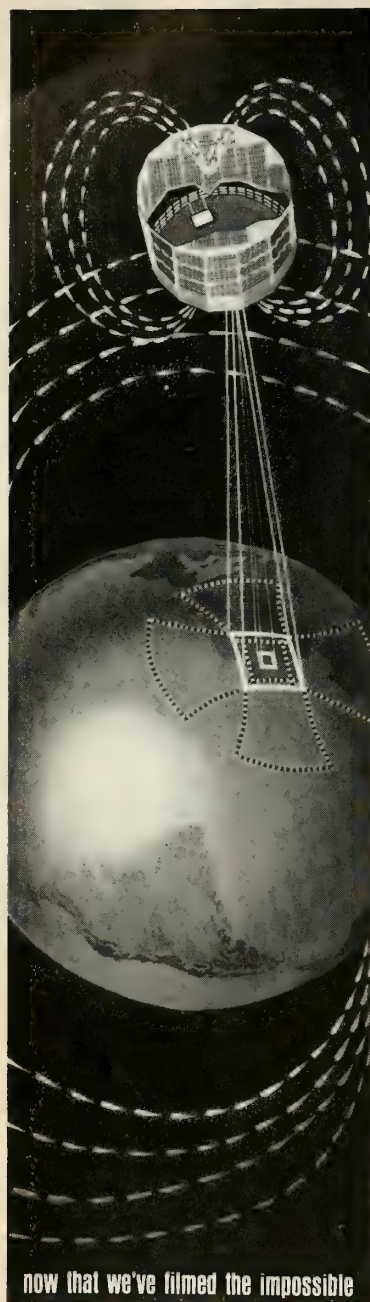
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## contracts

### NASA

\$419,885—J. W. Fecker Div., American Optical Co., Pittsburgh, Pa., for production of vacuum chamber and optical bench with an ultraviolet monochromator for Goddard Space Flight Center.

Dunn Engineering Corp., Cambridge, Mass., for an advanced air-bearing turn-table to evaluate the equipment that will guide the Saturn rocket through space. No amount disclosed.

National Research Corp., Cambridge, Mass., for a preliminary study of propellant feed systems for spacecraft ion engines. No amount disclosed.

### MISCELLANEOUS

\$5,000,000—Bendix Corp., N. Hollywood, Calif., from Sikorsky Aircraft Div., United Aircraft Corp., for helicopter-borne sonar systems.

\$3,000,000—FXR Div., Amphenol-Borg Electronics Corp., Broadview, Ill., from Sperry Gyroscope Co., for shipborne radar transmitters for use in Mobile Atlantic Range Stations (MARS) missile tracking program.

\$1,077,404—J. W. Fecker Div., American Optical Co., from Sperry Co.'s Marine Div., for development of two tracking optical telescopes for MARS.

\$211,500—General Electric's TEMPO, Santa Barbara, Calif., from Defense Atomic Support Agency, for establishment of an information center on the subject of high-altitude nuclear effects for use of government, industrial, and academic research workers.

The Siegler Corp., Los Angeles, from North American Aviation, for manufacture of hydrogen-peroxide fuel containers for the X-15 program. No amount disclosed.

### NAVY

\$59,100,000—General Dynamics/Pomona, Calif., for continued production of advanced Terrier and Tartar guided missiles. (Includes funds for operational spare parts for logistic support.)

\$16,103,259—Martin Co., Orlando, Fla., for Bullpup missiles.

\$10,845,000—Bendix Corp., Mishawaka, Ind., for first-phase development of new long-range shipboard Typhon antimissile missile.

\$9,223,331—Goodyear Aircraft Corp., Akron, Ohio, for Subroc missiles.

\$1,000,000—Radio Corporation of America Laboratories, Princeton, N.J., for Polaris command communications systems.

\$585,000—Vitro Laboratories, div. of Vitro Corporation of America, Silver Spring, Md., from BuWeps, for continuation of engineering services on torpedo system.

\$506,861—IBM's Federal Systems Div., Rockville, Md., for development of a high-volume production system for continuous manufacture of ultra-reliable thin-film subassemblies.

\$210,444—Capehart Corp., Richmond Hill, N.Y., for production of twelve AN/SPS-10 surface radar systems.

### ARMY

\$3,257,552—Raytheon Co., Waltham, Mass., for production of electronic components for Hawk missile system (subcontracted to Varian Associates, Palo Alto, Calif.)

\$1,556,831—Emerson Electric Co., St. Louis, for continued production of components and containers for Honest John rocket.

\$1,102,890—Aerojet-General Corp., Downey, Calif., for XAE drone development program.

\$34,833—Dr. A. R. C. Westwood, scientist Research Institute for Advanced Studies The Martin Co., Baltimore, for study effect of surface coatings on the behavior of metals.

Vernitron Corp., Carle Place, N.Y., from General Dynamics/Pomona, for development of a booster-less resolver chain for the Mauler missile system. No amount disclosed.

### AIR FORCE

\$14,650,000—RCA Service Co., Camden, N.J., for operation and maintenance service for White Alice communications system.

\$215,000—Communication and Data System Div., Collins Radio Co., Dallas, for high speed data-transmission equipment for Atlantic Missile Range.

\$175,000—Delco Radio Div., General Motors Corp., Kokomo, Ind., from The Boeing Co., for transistors for Minuteman ICE program.

\$137,000—Univac, St. Paul, Minn., for preparation of computer guidance program for a series of five NASA satellite launches in 1962.

\$80,000—Electro Mechanical Research, Inc., Sarasota, Fla., for a telemetry data conversion system for installation in Proving Ground Center's Mathematics Services Laboratory, Eglin AFB, Fla.

Bell Aerosystems Co., Buffalo, N.Y., for stability, control and performance study of experimental man-carrying rocket developed by Bell.

Optics Technology, Inc., Belmont, Calif., for research and development in the field of infrared fiber optics. No amount disclosed.

Packard Bell Computer Corp., div. of Packard Bell Electronics, Los Angeles, for production of two micrometeorological data systems; one for Cape Canaveral, other for Vandenberg AFB. No amount disclosed.

### REQUESTS

Proposals have been invited for a Nuclear Detection and Reporting System (System 477L-NUDETS) by the Electronics Systems Division of the Air Force Systems Command, Hanscom Field, Mass.

This system will be designed to automatically detect any nuclear explosion in the North American continent and report information on the blast to the North American Air Defense Command (NORAD) Headquarters in Colorado and to other government agencies.

The following firms have been invited to participate: Aerojet-General Corp.; Airborne Instruments Laboratory; Alpha Co. (Collins Radio); American Machine & Foundry Co.; Autonetics Div., North American Aviation, Inc.; Beckman Systems Div.; Bell Aerosystems Co.; Bendix Corp.; Burroughs Corp.; Convair; Cook Research Laboratories; Edgerton, Germeshausen & Grier, Inc.; Electronic Communications, Inc.; Fairchild Electronic Systems Div.; General Electric Co.; General Precision, Inc.; Hughes Aircraft Co.; International Telephone and Telegraph Corp.; Ling-Temco Electronics, Inc.; Lockheed Aircraft Corp.; The Martin Co.; McDonnell Aircraft Corp.; Motorola, Inc.; National Electronics Facilities Organization, Inc.; Philco; Radio Corp. of America; Raytheon Co.; Republic Aviation Corp.; Sperry Gyroscope Co.; Sylvania Electronic Systems; T. Ralph M. Parson Co.; Thompson Ramo Wooldridge, Inc.; United Aircraft Corp.; United ElectroDynamics, Inc.; Western Union Telegraph Co.; Westinghouse Electric Corp.

The proposals, scheduled to be received by September 29, will lead to a development contract for a prototype 477L System.

Small business firms and others interested in subcontracting opportunities should make direct contact with the above firms.

(Continued from page 7)

The first meeting was in May; in June we chartered with 65 members; we now have 95 members. The Mayor of Atlanta and the Governor of Georgia signed a proclamation establishing the week of Sept. 10-16 as Women in Construction Week.

In the short time that the Atlanta chapter has been organized, we have accomplished much. This is typical not only of our work in this organization but of the work that we do within the industry.

As my boss tells me, it is time that the females get a little recognition for the part they are playing in our expanding industry.

Ruth Rubin (Mrs. Monte Rubin)  
Publicity Committee  
Women in Construction  
Atlanta

## Thanks from Sweden

to the Editor:

I have reviewed your World Missile/Space Encyclopedia (M/R, July 17) and find this information very useful and interesting.

Thank you for a fine publication.

Fritz Tingstrom  
Stockholm  
Sweden

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## ECM Break Through

(Continued from page 34)

line is a given 90° quadrant. Multiple signals at different frequencies are displayed as many lines in the quadrant, each one at an angle that is uniquely a function of its frequency.

Frequency modulated signals are displayed as a solid angle—or a thickening of the line if the frequency deviation is low.

Other displays, or storage of the frequency information may also be used with the discriminator with an attendant increase in circuit complexity.

The frequency resolution in S-band compares favorably with a channelized receiver utilizing 80 filter sections and as many detectors and video amplifiers.

Absolute frequency indication is independent of incoming power level, as long as the "law" of the video detectors does not change. This suggests the use of a broadband limiter ahead of the discriminator if large signal environments are expected. Manually operated r-f attenuators may also be used to examine an occasional large signal.

• **Other uses**—Application of the WHIP principles, in addition to receivers, are in laboratory test equipment and ground checkout equipment use where quick frequency determination can be made. The light weight and low power consumption inherent in this type of receiver are particularly attractive in situations where frequency determinations are to be made in the uhf and microwave spectrum and these parameters are of prime importance.

Using the system for ECM applications, radio or radar frequencies can be identified readily. The WHIP receiver system can also make calibrations of amplitude and approximate r-f power measurements.

In electronic warfare, the WHIP receiver will function as a wideopen alarm, telling where to tune conventional narrow-band scanning superhetrodyne or trf receivers and jammers.

Its low cost and size should prove it adaptable to so-called "expendable jamming." Here, small missiles or rockets with jamming transmitters for warheads are used to provide an "electronic cover" for advancing troops, the receiver detecting enemy communication frequencies.

In the laboratory, the WHIP receiver fills the need for a simple, low-cost wideband frequency detector for rfi studies.

‡

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# A Spotlight for Rover

**T**HE SCHEDULE in the *Rover* program calls for test flight of a nuclear rocket engine by 1965. Use of these engines may make possible direct manned flights to the moon by the 1967 target date.

Importance of the *Rover* program to U.S. efforts to beat the Russians to the moon is, therefore, evident. All of the big *Saturn* and *Nova* boosters are to be designed so they can lift nuclear upper stages.

The program deserves highest priority.

Yet, as associate editor Frank McGuire points out in our lead article this week, the *Rover* program is running into the same snarls which tied the equally-important *Atlas* and *Titan* ICBM programs into knots.

Just as with the much-publicized missile base delays, the difficulty centers around construction. Contractors are trying to save money; labor unions are walking off the job; management is too powerless or too inept to do anything about it; contracting procedures force the letting of contracts to unqualified bidders.

The whole mess has such a familiar ring to it that it sounds like the nightmare on missile base construction all over again. But there is a big difference. The ICBM programs were military. Once the truth about the ICBM base delays became evident, the Air Force and Army Corps of Engineers moved swiftly to remedy the situation.

No such sense of urgency is evident in the current situation.

Look at the slippage in testing the reactors which are leading to a flight engine. Some observers believe Kiwi A actually could have been tested a year earlier than it was, although AEC officials are inclined to dispute this. Kiwi A-Prime was delayed six months. Kiwi B 1A already is four to five months behind schedule. There is a possibility it may not meet its new target date next month.

Greedy contractors and irresponsible labor unions are not entirely to blame for the situation, by any means. Equipment vital to the test cells is delivered late by the manufacturers, forcing contractors to lay off help while marking time. Specifications are changed; then changed again—and again.

It is not news that the *Rover* program is having administrative difficulty. That was evident some time ago and at least two Congressional committees have taken a look at the program for that reason. It is news that so little is being done about it.

The House Space Committee recommended some months ago that management of the program be overhauled to give more authority to the joint NASA-Atomic Energy Commission Space Nuclear Propulsion Office headed by Harold B. Finger.

It asserted in a staff report that the office should have "sufficient authority effectively to direct the

progress" of *Rover* and that the funding level of the Nevada facilities should be restudied. Purpose of the latter recommendation was to assure that adequate support and test facilities will be ready when needed.

We have seen no indication that these recommendations are being implemented. NASA Administrator James E. Webb indicated recently that a step-up in the program is under consideration. This would mean early naming of a contractor for the nuclear rocket engine, an action not expected under present schedules before 1962.

But early contractor selection, while welcome, would not in itself be sufficient. In view of the continuing delays in the program, its management should come under close scrutiny. If more authority is needed before a proper job can be done, it should be provided. If the management already has the necessary authority and is too ineffective to use it, the management should be changed.

This program is too important to the nation to be allowed to slip further into the same sordid morass that bogged down the ICBM programs in their later stages. We should profit from that lesson. The time to save the *Rover* project is right now, not farther down the line.

The Senate's Permanent Investigating Subcommittee did a good job in its investigation of the difficulties which delayed construction of U.S. missile bases. It is cognizant of the labor practices and the management problems which plagued those projects.

Disclosures before the McClellan subcommittee did much to jar both the Department of Defense and the Kennedy Administration into action. The National Missiles Sites Labor Relations Committee, set up under Labor Secretary Goldberg, was given sufficient power to clean up the situation, as witnessed by settlement of the wildcat walkout at *Titan* sites near Denver just last week.

**I**F THE McCLELLAN Subcommittee was instrumental in bringing the facts to light on the ICBM programs, it might very well be worthwhile for the same committee to take a look at the *Rover* program.

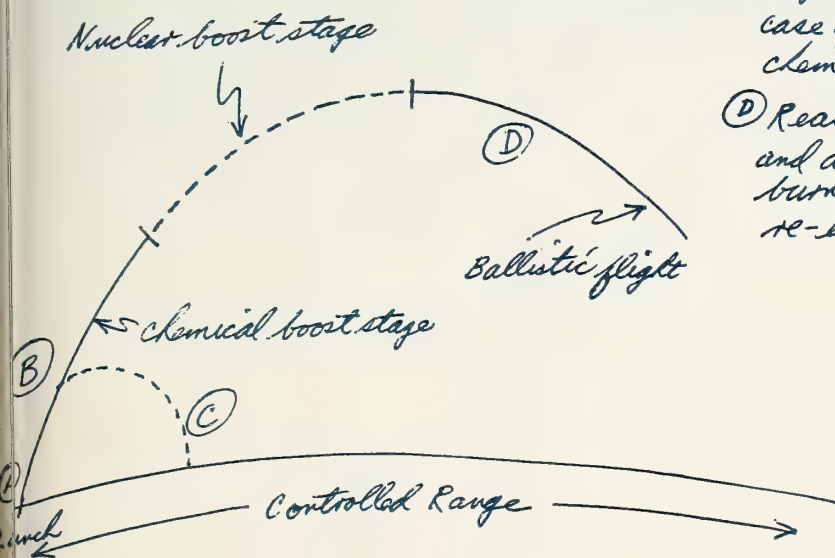
As one of the officials interviewed by Mr. McGuire said: "There is nothing to distinguish this program in importance from our ICBM base-activation program except that the missiles are a bit closer in urgency. We will be staking our lives in a few years on nuclear rockets because of what they can do, and there is no time for sabotage-by-neglect to be allowed such a stranglehold on the program."

A public spotlight would do much to clean up the mess.

William J. Coughlin

## ARTIN NUCLEAR ROCKET PROGRAM

- REACTOR DESIGN
- PROPULSION REACTOR START-UP
- NUCLEAR ROCKET SAFETY ANALYSIS
- RADIATION EFFECTS ON ROCKET SYSTEM
- FUEL ELEMENT DEVELOPMENT
- VEHICLE DESIGN
- CRYOGENICS



### Safety Requirements

- (A) Safe disposition of reactor in case of launch pad abort
- (B) Rapid reactor start-up without risk of a nuclear excursion
- (C) Safe disposition in case of abort during chemical boost
- (D) Reactor fragmentation and aerodynamic burn-up during re-entry

## SAFETY ASPECTS OF NUCLEAR ROCKET FLIGHT TESTING

Safety is one of the many areas receiving continuous attention in the U. S. nuclear rocket program. Tests must be conducted to obtain data, to develop safety systems, and to demonstrate safety.

During the past several years, Martin has gained considerable experience in the safety field through its investigations and tests concerning the use of radioisotope-fueled generators for auxiliary power in space. Analytical investigations of nuclear rocket safety conducted by the company under the RIFT (Reactor in Flight Test) program for the National Aeronautics and Space Administration are being continued. The U. S. Atomic Energy

Commission's SNAP program, under which The Martin Company developed the radioisotope-fueled generator that powers two radio transmitters in a Transit satellite, involved exhaustive safety studies and tests. This was the first use of atomic energy in a space vehicle. Experience in computer analysis of booster behavior, flight test of large boosters (VIKING, VANGUARD, TITAN and PERISHING) at Cape Canaveral, re-entry, system integration, missile test range control and rocket destruct systems, as well as extensive experience in nuclear technology, has been invaluable in the development of technical capabilities and facilities required for these investigations.

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Aerojet-General's glass filament winding process, AeroROVE, is a simple technique applicable wherever outstanding reliability and high load carrying capacity per unit weight are required.

Aerojet has built and tested the world's largest filament wound rocket chamber. This experimental Polaris motor, made of a million miles of glass thread, is three times the size of any glass case ever successfully fired.

STRUCTURAL MATERIALS DIVISION

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Engineers, scientists: investigate outstanding opportunities at Aerojet.



OCTOBER 2, 1961

# missiles and rockets

THE MISSILE / SPACE WEEKLY



Republic's Long-Life Plasma Space Engine

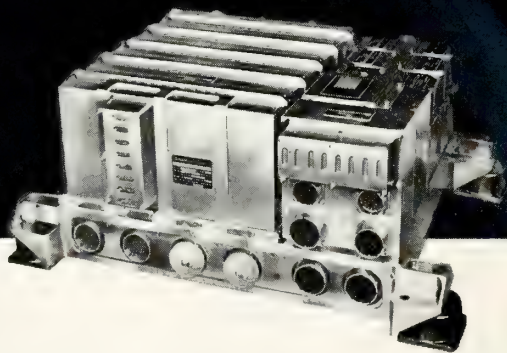
**DOD + NASA: \$55.5 Billion in FY '63?**  
**Apollo Boss Promised Needed Authority**  
**'Daco' May Help Fill Pre-Saturn Gap**

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## **GUIDANCE COMPUTER for NASA'S CENTAUR**

Sometime this year, CENTAUR will be spaceborne. Already, the projected uses of CENTAUR bear fascinating implications for the future... placing a satellite in an orbit so exacting that it will remain in one spot over the earth's surface... soft landings on lunar and planetary bodies... timed launching of several satellites from a single vehicle. Several major guidance functions will be performed in CENTAUR by a compact digital computer system from Librascope. It weighs 62 pounds, occupies little more than  $\frac{3}{4}$  cubic foot. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

*computer control systems  
that pace man's expanding mind*

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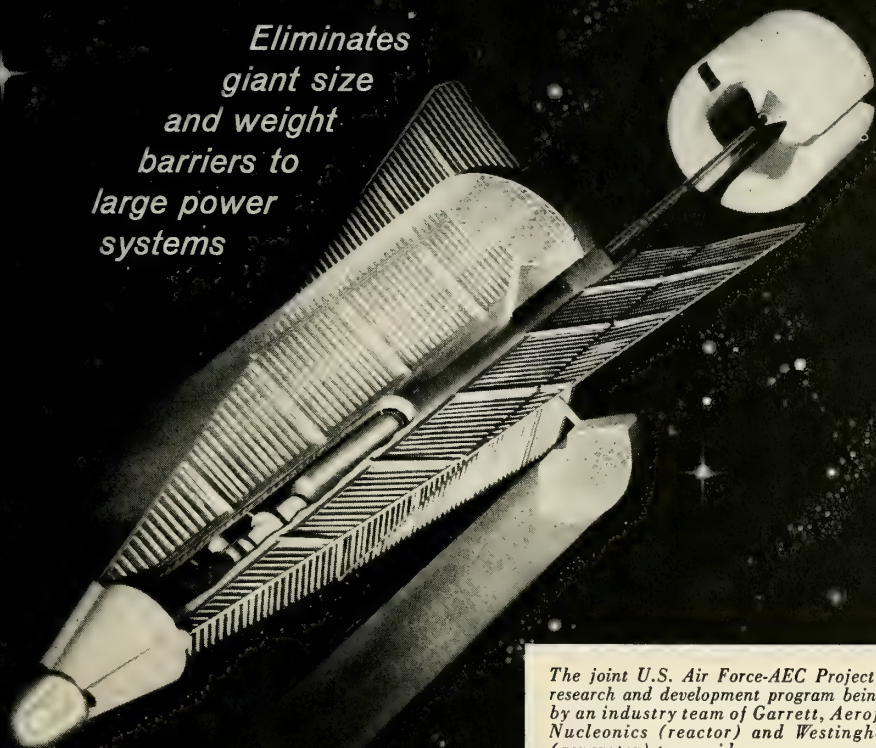
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# GARRETT-U.S. AIR FORCE 'SPUR'

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*Eliminates  
giant size  
and weight  
barriers to  
large power  
systems*



The joint U.S. Air Force-AEC Project SPUR is a research and development program being conducted by an industry team of Garrett, Aerojet-General Nucleonics (reactor) and Westinghouse, Lima (generator) to provide a power source to produce 300-1000KW electrical power in space for one year or more. Power is obtained by conversion of nuclear fission energy to mechanical (shaft) power with a potassium vapor turbine. Equipment includes: reactor, primary and secondary loop pumps, boiler, turbo-generator and condenser-radiator.

Long lead time is essential to the development of large nuclear space power systems. Present methods of power generation would require an impractical heat rejection surface nearly the size of a football field for a power output of one megawatt—power which will be needed for critical space missions already in the planning stage. Garrett's AiResearch Divisions have

now completed the initial SPUR design studies and proved the project's feasibility to supply continuous accessory power and low thrust electrical propulsion in space for long periods of time.

Cutting projected 1 MW power systems to 1/10th the size and 1/5th the weight of present power systems under development will be possible because of SPUR's capability to operate at higher temperatures, thereby sharply reducing the required radiator area.

Garrett has been working with the Air Force and the Atomic Energy Commission on SPUR as the prime contractor for more than one year and has more than five years of experience in space nuclear power development. Also an industry leader in high speed rotating machinery, heat transfer equipment, metallurgy and accessory power systems, the company is developing design solutions for SPUR in these critical component system areas.

**THE GARRETT CORPORATION**



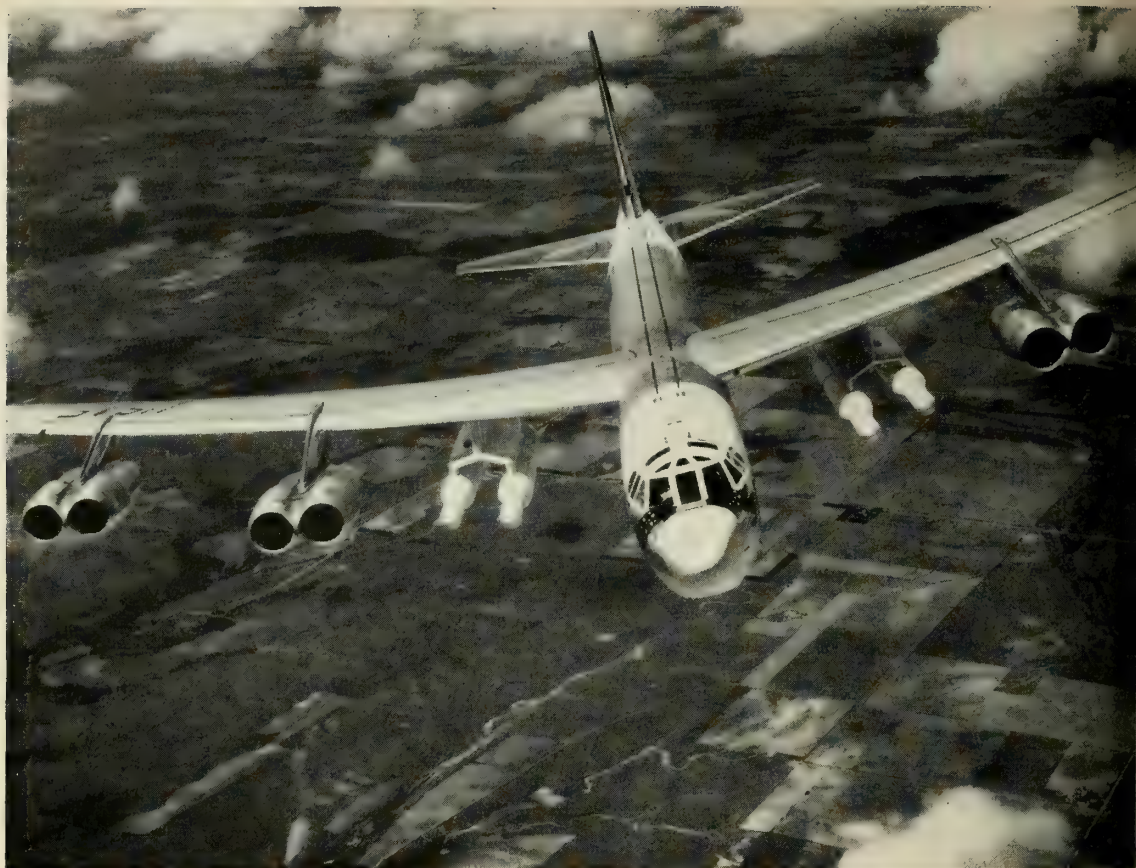
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**FLYING MISSILE LAUNCHER.** New Boeing B-52H missile bomber can take off faster, fly farther and strike harder than any previous B-52. It's shown here carrying models of four hypersonic Skybolt air-launched ballistic missiles, a 1000-mile range weapon

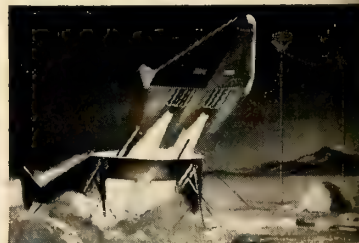
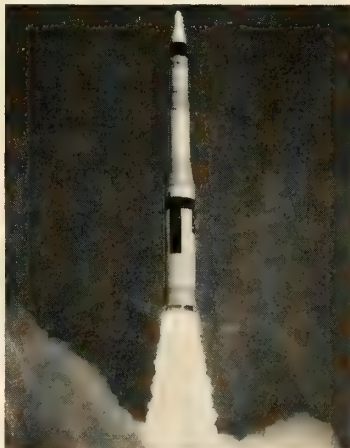
now under development. The Strategic Air Command B-52, most versatile long-range weapon system in the U. S. Air Force arsenal, can also carry supersonic Hound Dog missiles for inflight launching, in addition to its regular bomb-bay load of gravity bombs.

## *Capability has many faces at Boeing*



**THREE-ENGINE JET.** Scale model of America's first short-range jetliner, the Boeing 727. Already, 117 Boeing 727s have been ordered by American, Eastern, Lufthansa and United airlines for delivery beginning in 1963.

**MINUTEMAN,** first U. S. Air Force solid-fuel intercontinental ballistic missile, scheduled to be operational in 1962, will be stored ready for quick launching in underground silos. Boeing is weapon system integrator for Minuteman.



**MARS DEPARTURE.** Artist's concept of man space vehicle taking off from Mars for return to earth. This space transport system, based on a Boeing study, would enable exploration scientists to spend months on Mars with instruments and life-support equipment. Boeing scientists are at work on many phases of space flight.

**BOEING**

# missiles and rockets

Volume 9, Number 14

October 2, 1961

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**THE COVER**

*Republic technician inspects XE-1A plasma  
pinch space engine, which company says  
will be test flown early next year. It is re-  
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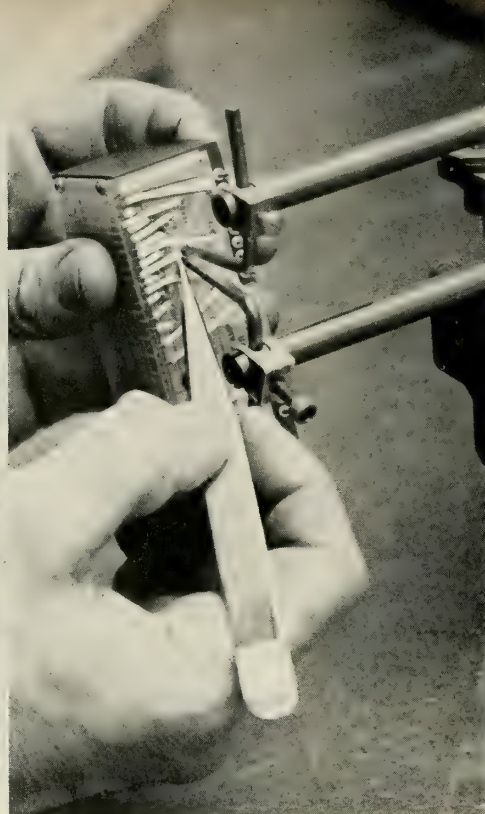
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†U.S. Reg. Pdg.

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Package design of Weld-Pak® module

Welding interconnections on Weld-Pak® module

Raytheon Weld-Pak® logic module

## Raytheon "Know-How" Supports M.I.T.'s Advanced Polaris Development

Raytheon is presently devoting part of its unique industrial support talents and facilities to system design engineering and manufacture of electronics for the Advanced Polaris Guidance System. For this program Raytheon is under technical direction of Massachusetts Institute of Technology's Instrumentation Laboratory.

For other university or government laboratories, major missile, space and weapons systems contractors, Raytheon capabilities are ideally suited to basic production design, prototype and production manufacture,

flight and environment testing, and field support of operational equipment.

Reinforcing these capabilities is Raytheon experience as prime contractor-systems manager on two major missile programs — U. S. Army's HAWK, U. S. Navy's SPARROW III. Related achievements include Raytheon's famed Weld-Pak® all welded, high density analog and digital components, hydraulic actuators, valves of exacting dimensions, electrical power units, extremely favorable power-to-weight ratios, weapons systems radomes, missile guidance miniature rate gyros.

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## Apollo Guidance, Cont.

To the Editor:

I heartily concur with your opinion that "guidance for a program of the *Apollo* type must be developed early" (editor's comment on letter headed "Apollo Guidance," M/R, Sept. 11, p. 6). The hazarding of valiant Americans on a mission of this order is not to be undertaken lightly, even in the present charged international climate. The prospects that this program portends for the military capabilities upon which civilization itself may depend only serve to emphasize the cogency of your comment.

When one considers the pressing time scales currently being discussed for the *Apollo* program, and the stringent accuracy and reliability requirements inherent in its manned mission, it is readily apparent that the time necessary to develop new components and systems to the required levels just is not available. This means that the *Apollo* system must be based on current program performances.

A more dramatic way of visualizing the problem is to complement the reliability figures to yield the probability of failure and then estimate the number of satisfactory flight tests necessary to reduce this probability to the levels dictated by the national interest and crew survival. For unmanned systems a high probability of failure can be overcome by increased deployment, i.e., by dollars, whereas for a manned mission no such simple solution is available. Even with astronauts of the calibre of Shepard and Grissom, willing to take the risks, the national interest cannot tolerate another *Vanguard* fiasco.

It was therefore with nothing less than shock and dismay that I read of NASA intentions to contract directly for the development of guidance and control for *Apollo* without even a most cursory review of current systems performances. The inexplicability of this action is only compounded by the companion decisions to designate a different contractor for production and to delay selection of this second team-member until the development is completed. . . .

If the design study by MIT reported in your issue of Aug. 14 (p. 37) is supposed to constitute a review of current capabilities, just how comprehensive was it? The acknowledged objectivity noted in your TECHNICAL COUNTDOWN of Sept. 4 (p. 21) hardly bodes an unbiased evaluation of all factors. Was the possibility of combining proven elements (gyros, accelerometers and computers) of several current systems to yield a near-optimum *Apollo* system even considered? To what extent were the reliability, performance and schedule penalties of the proposed hydra-headed program prosecution assessed?

Without attempting to cloud the brilliant escutcheon of Dr. Draper, one can readily state that the very diversity of current systems applications and industry capabilities forbids the letting of such

a critical contract without the most thoroughgoing review of existing programs. One is driven to conclude either that NASA lacks the in-house capacity to conduct such a review or that current performance results are so enmeshed in security measures that they are effectively lost within the Administration. . . .

Immediate and vigorous Administration and/or Congressional action to correct this circumstance is urgently needed. Responsibility for the planning and direction of *Apollo* should of itself endow NASA with all the requisite security qualification and "need to know" for current performance information.

The following telegram on this subject was sent to Senator Jacob K. Javits (R-N.Y.) when public announcement of the proposed contract was first made on Aug. 10:

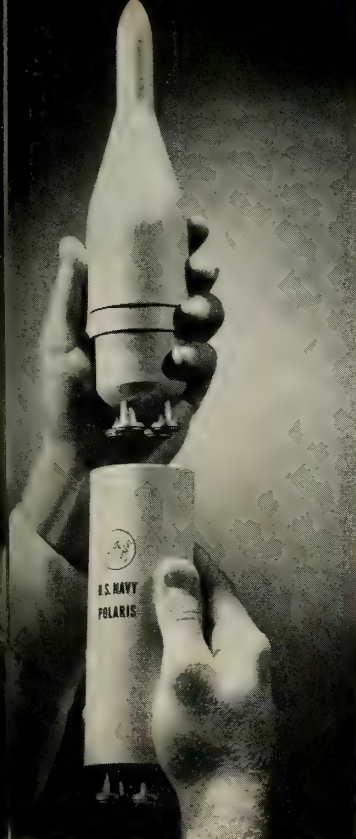
HON. JACOB JAVITS  
URGENTLY REQUEST YOU INVESTIGATE NASA CONTRACT MASS INSTITUTE TECHNOLOGY FOR APOLLO GUIDANCE. PROTEST DENIAL OF COMPETITIVE BIDDING THIS CRITICAL TASK. SUGGEST NO CONTRACT WITHOUT COMPLETE REVIEW ALL CURRENT INERTIAL GUIDANCE SYSTEMS FOR PROVEN ACCURACY AND RELIABILITY. REVIEW MUST INCLUDE SYSTEMS NOT BASED ON MIT DESIGNS. YOUR COMMENTS DESIRED.

Subsequent correspondence from Senator Javits included a copy of a NASA letter acknowledging his inquiry and promising comment on the above telegram. To date (Sept. 14) no such comment has been received.

Although I am presently employed in evaluation activities for the *Atlas* Inertial Guidance System at American Bosch Arma Corporation, my concern in this matter stems solely from my position as a citizen. There is no interest in reopening any industry-versus-arsenal controversy; it is fully appreciated that two of our most effective missile systems, *Side-winder* and *Redstone/Jupiter*, are arsenal developments. Nor is it sought either to "shoot down" MIT or to promote my own company's fortunes. The only objective is to see that the most effective system is installed in the *Apollo* vehicle, be it designed by MIT, Arma, Autonetics or any other capable organizations. . . .

At the very minimum, NASA must be compelled to consult independent sources of current performance achievement and have data on all tests, both successful and unsuccessful, presented for objective evaluation. Space Technology Laboratories, in its capacity as technical adviser to the Air Force for the Ballistic Missile Program, constitutes a direct source of data on the *Atlas*, *Minuteman*, and MIT-designed *Thor* and *Titan II* programs available to NASA. This source would also afford a significant buffer to direct contractor promotional efforts. . . .

Frederick J. Howard  
Freeport, L.I., N.Y.



the Polaris Advanced Guidance System, Raytheon applies E-T-oriented program management techniques throughout, plus following industrial support

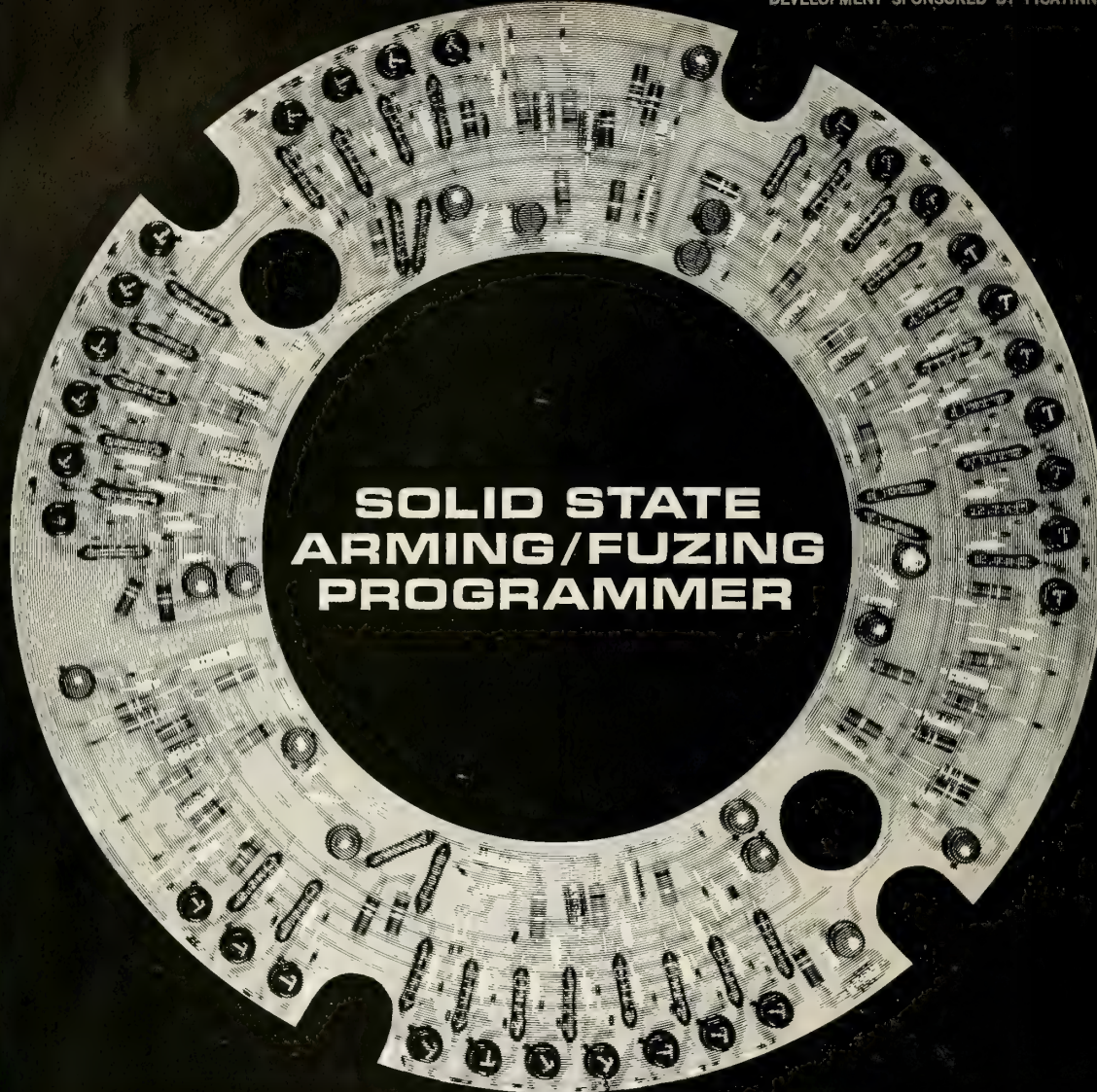
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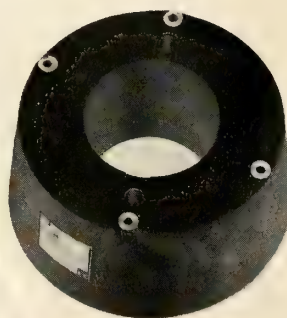




# SOLID STATE ARMING/FUZING PROGRAMMER

**All-electronic digital timing programmer controls atomic warheads with better than 0.1% accuracy under extreme environmental conditions**

Developed in cooperation with the U. S. Army Tactical Atomic Warhead Laboratory at Picatinny Arsenal under a program of supporting research, this new digital timing programmer represents a significant advance in the state-of-the-art for arming/fuzing devices. For this particular application, the programmer includes two identical channels, each with a 4-stage, adjustable timing program accurate to within 0.1% under any combination of temperature ( $-65^{\circ}\text{F}$  to  $+165^{\circ}\text{F}$ ), voltage ( $26.5 \pm 5.5 \text{ Vdc}$ ), vibration (50 g's/2000 cps), shock and acceleration (100 g's). This new standard of accuracy under rugged environmental conditions is, however, practically meaningless until it is combined with another, equally important consideration always present in modern atomic weapon systems — *reliability*. The programmer's proven solid state design, *without any moving parts*, together with the unique packaging methods utilized, potentially offers a safety-reliability level substantially higher than previously attainable.



This arming/fuzing device is only one specific application of Tempo's exclusive solid state digital programmer design. Circuit versatility permits an almost infinite number of applications. Number of functions to be controlled is limited only by the allowable physical size of the device. Timing increments can be as close as 10 microseconds. Functions can be fixed or variable in time from the application of power or from a control signal. Two basic characteristics, however, are present in all versions; high degree of accuracy and maximum reliability — both guaranteed under a wide range of extreme environmental conditions. If these characteristics are vital requirements of your timing programmer, Tempo can help you.

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# The Countdown

## WASHINGTON

### More Space for the Air Force

Air Force officials are seeking a much stronger voice in NASA's man-to-the-moon operation, including greater use of AF facilities and management capability. Discussions to improve NASA-AF cooperation now are underway. The Air Force is confident that within the next few months it will be assigned a much larger role in the national space program.

### Meanwhile, Back at AFSC . . .

The new Bioastronautics Systems Division of the Air Force Systems Command becomes a reality this month. It incorporates all of the Air Force's scattered bioastronautics facilities. With Congress watching closely, the move is certain to make much more difficult NASA's attempts to build up its own bioastronautics capability.

### Army R&D: Who Does What

Informed sources have come up with some new figures on where the Army is spending its R&D dollars—all \$1.2 billion of them. Some 63.5% is spent with industry; some 36.5% in-house. About one-third of the total Army R&D budget is going to *Advent*, *Mauler*, *Pershing* and *Nike-Zeus*.

### Slippage of the Month

October is the month when the *Polaris* sub-building program will begin slipping again unless the Administration moves quickly. The problem: no authorization for procurement of long-lead-time items beyond 29 ships. The result: Month-by-month slippage for all ships beyond the 29th.

### Scientific Council for Air Force

In an attempt to improve communications between its scientists and technical experts, the Air Force has set up a Council of Air Force Scientists under AF chief scientist Dr. Leonard S. Sheingold. Military director will be Lt. Gen. Roscoe C. Wilson, deputy chief of staff for research and technology. The group is to provide a pool of military and civilian scientific consultants for technical advice and for coordination of technical information.

### End-of-the-line Not in Sight

Air Force Vice Chief of Staff Gen. Frederic H. Smith, Jr., is sounding the alarm against consideration of the ICBM as the ultimate weapon. "What kind of a stalemate would exist if we froze on today's weapons and the Soviets developed a defense against the ICBM?" he asks. "Or how would we feel about a 'stalemate' if enemy armed satellites were overflying our cities or bases a mere 100 miles up?"

## INDUSTRY

### Training for Pershing

A training program is under way at Martin-Orlando for an initial contingent of 250 military and civilian personnel of the *Pershing* missile system. Courses, ranging from 6 to 16 weeks, are designed to teach technical characteristics of the *Pershing* system to Army military

missiles and rockets, October 2, 1961

and civilian instructors and supervisors who will operate, maintain and support the *Pershing* in the field.

### GE's ComSat Out of Business

General Electric is dissolving Communication Satellites, Inc., the corporation created to put GE into the communications field as a carrier. GE has also formally withdrawn its request to take part in operation of a U.S. space communications system. Decision followed the Federal Communications Commission ruling that operation of the system would be limited to international common carriers.

### New BMEWS Project Manager

William L. Richardson (Maj. Gen. USAF, ret.) has been named general manager of RCA's Major Defense Systems Division, replacing D. Brainerd Holmes, who will head up NASA's *Apollo* program. Richardson also will serve as project manager for the AF Ballistic Missile Early Warning System (BMEWS).

### Tory Tests Beginning Again

Tests of the *Pluto* reactor are being resumed by the Atomic Energy Commission at its Nevada test site. The full-power run of the Tory IIA-1 reactor is the first since May 14.

### SLAM Decision Due Shortly

Fate of Project *SLAM*, the supersonic low-altitude missile, hangs on the report of an ad hoc committee due to go this week to DOD's Dr. Harold Brown, director of research and engineering. Best guess on the recommendation: an increase in funding but no okay for a flight test program.

### MA-5 Flight Is Set

NASA is pushing industry teams hard to meet an early November target date for orbital flight of the *MA-5*. Best bet is that a monkey will ride the McDonnell capsule, although a final decision has not been made. The NASA schedule calls for three manned *Mercury* orbital flights following the *MA-5* shot. These are to be followed by two more launches which will send crews of two or three monkeys on orbital flights of up to two weeks.

### New Oceanographic Sub Scheduled

General Dynamics' Electric Boat Div. will build *Aluminaut*, an oceanographic research submarine designed to operate at depths of 15,000 ft., for Reynolds International at a price of \$2 million. Fifty feet long and with an operating range of 80 miles, it is the first sub ever to be built of aluminum. Launch date: 1963.

## INTERNATIONAL

### Soviet Protest on West Ford

The Soviet Academy of Sciences has joined in the protests over Project *West Ford*, the U.S. communications experiment designed to sow 350-million copper dipoles in earth-orbit. A letter to the U.S. National Academy of Sciences said the sowing of copper filaments "may have dangerous consequences to artificial satellites, especially those with a man on board."



# The Missile/Space Week

## S-1<sup>b</sup> Bidders to Meet

NASA will hold a bidders conference on the S-1<sup>b</sup> stage of the *Saturn* booster in New Orleans on Oct. 4.

No official decision has been announced as to whether the stage will have two or four F-1 engines.

Thirty-two firms attended the bidders conference on the first stage of the *Saturn* C-1 booster held there last week.

Twenty-eight companies asked for copies of the specifications. The booster will be built according to Marshall Space Flight Center design but a product improvement program will be undertaken concurrently.

Bids are due on Oct. 16; the contract will be awarded about Nov. 15.

The same 37 firms invited to the C-1 first stage conference will also be permitted to bid on the S-1<sup>b</sup> first stage.

The stages will be built by different contractors, however.

The following firms did not ask for C-1 specifications: Bell Aerospace, Firestone, Goodyear, Grumman, Hughes, McDonnell, Raytheon, Sperry Rand, and Western Electric.

## Zeus Development Refueled

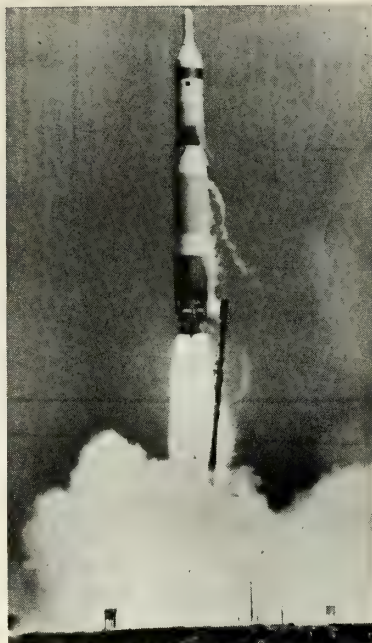
An additional \$171,821,000 contract has been received by Western Electric Co. for continued development of the *Nike-Zeus* antimissile missile. Subcontractors and suppliers in many states will share in the funds.

These include Goodyear Aircraft, Continental Electronics, Avco, Cornell Laboratories, Continental Can, Remington Rand, Sperry Rand, and New Mexico State University. The Army said some of the contract money will be spent at the *Zeus* testing station nearing completion on Kwajalein Island in the Pacific.

More than \$1 billion now has been put into *Nike-Zeus* development. (For a progress report on the *Zeus* system, see p. 32.)

## Shots of the Week

- Third shot in the current Soviet series of missile firings into the Central Pacific (M/R, Sept. 25, p. 10) impacted in the designated target area



### 'Significant Milestone'

*TITAN I'S 5300-mile flight from Vandenberg AFB to near Wake Island was called by AF "a highly significant milestone at a significant time in history."*

southwest of Hawaii on Sept. 21. A Tass report said that in addition to check-out of guidance equipment, the firing was a test of communications equipment for the orbiting of future satellite spaceships. Next Soviet space spectacular may be timed to coincide with the November anniversary of the Russian revolution.

- A Martin-built *Titan I* successfully passed its first complete operational systems test on Sept. 23 when it was lifted by elevator from its underground silo for a 5300-mile flight from Vandenberg AFB. Impact was in the target area near Wake Island.

- At Cape Canaveral, Martin's *Pershing* scored its 18th success in 22 test launchings with a 200-mi. flight on Sept. 26. The Army said the firing was a special test to evaluate performance in a relatively short-range trajectory. It said all test objectives were met, including an evaluation of warhead components. Production of *Pershing* is to begin shortly, the Army said.

- Test flight of the North Amer-

ican X-15, with Navy Comdr. Forrest S. Petersen at the controls, was cancelled on Sept. 27 due to high cloud cover over Edwards AFB. The flight, to check ability of the rocket plane to withstand 1000°F temperatures, was re-scheduled for the following day.

## Entac Builder Disclosed

An unheralded defense company has been identified by the French Armed Forces Ministry as a major manufacturer of the *Entac* antitank missile. More than 10,000 of the missiles have been turned out under the direction of the government prime—Direction d'Etudes et Fabrications d'Armement (DEFA)—which also manufactures the weapon.

L'Atelier de Construction de Puteaux, located near Paris, was identified this week by the Armed Forces Ministry as a main *Entac* manufacturer. DEFA also manufactures the antitank missile, which is designed and which remained under tight security until the U.S. Army decision to purchase \$20-million worth (M/R, Mar. 27, p. 14).

Other countries, including Belgium, are reported to be interested in *Entac*, and an additional production source has become necessary. Nord Aviation has been selected to produce *Entac* starting early in 1962.

Nord has considerable experience in this field, having built an antitank series and air-launched missile. DEFA has designed several different *Véronique* research rockets and the widely used solid-fuel *Parca*, a mobile Army surface-to-air training weapon. It is also developing a "super" *Parca* for defense against high-altitude, high-Mach aircraft.

The French Ministry said "Delivery of *Entac* missiles to the U.S.A. in December, 1961, will be effected by DEFA."

Figures on *Entac* performance show a range of about 1 mile and speed of 180 mph.

## Mars-Venus Life Probe Set

NASA plans to launch a search for life on Mars and Venus in 1966-67. A \$380,640 contract has been awarded to the Hughes Aircraft Co. for missiles and rockets, October 2, 1961.

warded to Stanford University for design of a device which can examine microscopic organisms or chemicals or traces of nucleic acids, basic to all living matter. The instruments, equipped for telemetry, will be landed on the planets by space probes.

"If life exists or has existed on a planet, evidence would be found in any drop of water, pinch of soil or gust of wind," says Stanford's Dr. Joseph Lederberg. The professor of genetics, winner of the 1958 Nobel prize in medicine, is working on the project with Dr. Elliott C. Levinthal, research physicist.

## OD Intelligence Leaks

The Defense Department is trying to cut down on dissemination of data on new weapons. Arthur Sylvester, assistant secretary of defense for public affairs, says DOD is taking steps to close up the sources and methods by which intelligence information is getting out.

His remarks came shortly after the House Information Subcommittee released its six-month assessment including Kennedy Administration in-

formation policies. The report said the Administration got off to a confused start but now has resolved to protect the people's right to know the good and bad of U.S. military security.

The subcommittee, headed by Rep. John Moss (D-Calif.), admitted, however, that it was unsuccessful in lifting the Navy's classification of its telephone book.

## Front Office Changes

Robert C. Jackson will become president of Ryan Aeronautical Co. on Nov. 1. His election was announced last week by T. Claude Ryan, who will step down as president of the firm but retain his positions as chairman of the board and chief executive officer.

Jackson has been executive vice president of Ryan for the past two years, following his 1957 appointment as a director. As a graduate of



JACKSON

Stanford University in 1929, he studied at the Harvard Graduate School of Business and then returned to Stanford to take his master's degree at the business school there. Before joining Ryan, Jackson was connected with a number of Southern California firms.

At Curtiss-Wright Corp., I. Nevin Palley was named executive vice president. Palley formerly was president of ITT-Federal Laboratories.

At Northrop Corp., Dr. William F. Ballhaus, executive vice president, was elected to the company's board of directors to fill the vacancy created by the death of Dr. Howard P. Robertson.

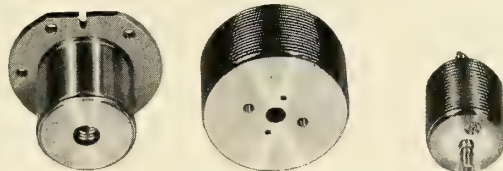
## Soviets Arrive for IAC

Nine Russian space scientists are expected to attend the 12th International Astronautical Congress, opening in Washington Oct. 2. Chairman of the conference is Prof. Leonid I. Sedov of the Soviet Academy of Sciences. More than half of the 200 technical papers to be presented at the five-day session are by non-American experts.

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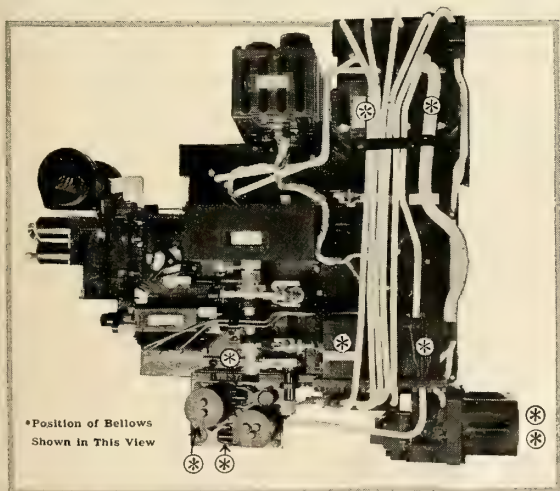
There are twenty three welded diaphragm bellows in the air inlet control shown here. The assembly includes eight different bellows engineered expressly for the installation.

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# DOD, NASA May Ask for \$55.

**Services working with new  
'program decisions' handed  
down by McNamara; deeper  
crisis would swell total**

by James Baar

THE PENTAGON is now moving toward proposing a Fiscal Year 1963 spending budget of around \$52 billion.

At the same time, NASA is considering a FY '63 budget totaling around \$3.5 billion.

Both figures are still tentative. They could be altered radically by such unresolved matters as the Berlin crisis, arms control and the military role in the U.S. space program.

However, Defense Secretary Robert S. McNamara last week took a long stride forward in the FY '63 budget-making process by sending the military services his much-awaited "program decisions"—his decisions on the military forces that he thinks the nation should

maintain and build.

Informed sources indicated that a considerable part of the increased defense spending would be for procurement of additional *Polaris* submarines and *Minutemen*—probably fixed-base. Some experts are contending the expected increase in the size of Soviet nuclear warheads is making the mobile *Minuteman* more vulnerable than super-hardened fixed bases.

The military services have been directed to submit budgets to match the programs within about one month. Then the Defense Department will begin its usual review of the total defense budget requests with the Bureau of the Budget.

This procedure of submitting budget requests on the basis of previously determined programs is a sharp break with the past.

• **New stress on programs**—Previously, the Defense Department after consultation with the White House gave the military services budget guidelines in terms of dollars. For example, last year the services were instructed to submit three budgets: one based on the dollar total of their FY '61 budget; one based on a cut in the FY '61 budgets;

and one based on an increase.

Military programs, despite occasional pious denials, were trimmed and molded to fit the dollar totals.

McNamara and Pentagon Comptroller Charles J. Hitch have reversed this procedure, at least to a considerable extent. This has been done by adopting many of the approaches advanced by Hitch last year in a book resulting from Rand Corp. studies.

Under these approaches, programs would be determined first on the basis of the cost effectiveness of alternative program levels. Then budgets would be put together to match the approved programs.

In April, Hitch directed that the various units of the Armed Forces be regrouped for budgetary purposes into program packages based on common missions. The program packages, in turn, were to be made up of program elements such as B-52 wings, infantry battalions and ICBM squadrons.

He directed that the total cost of the elements and packages were to be determined not only for FY '63 but for the next five to 10 years. This would make it possible to determine the cost

## Potent Arguments for Bigger Military Space Program

CURRENT AIR FORCE pressure for a greatly expanded military space program would—if successful—bring about considerable revisions in Defense Department budget plans over the next several years.

Many of the arguments advocating such a military space program were stated publicly in the bluntest terms to date during a high-powered panel discussion at the recent Air Force Association Convention in Philadelphia.

Here are some of the key statements made by panel members.

**Dr. Walter Dornberger**, vice president of Bell Aerosystems Co. and former head of the German V-2 program:

"We can be sure that the Communists have realized that a military stalemate now exists, which may prevent them from ever achieving their goal through conventional political or military means. . . . In such a situation the Russians would be utterly foolish not to direct their efforts toward military superiority in space. According to Khrush-

chev's repeated statements, they are convinced they are ahead of the free nations of the world in the conquest of this space. Here, I am sure, the Russians recognize an opportunity for obtaining a new and unique military superiority.

"Besides many others, reconnaissance, weather, navigation, communication and detection satellites the same as spacecraft for bombardment, inspection, interception, command, maintenance and supply could contribute to this military space force. If an enforced agreement with Russia about the peaceful use of space cannot be obtained, we will find one day this variety of defensive and offensive weapon systems established and ready to operate. . . ."

**Dr. Edward C. Welsh**, executive secretary of the National Aeronautics and Space Council:

"In my view, we do not have a division between peaceful and non-peaceful objectives for space. Rather, we have space missions to help keep the peace,

and space missions to help increase our ability to live well in peace.

"The Communists have expressed their determination to dominate the world, and they will use all methods available for attaining that objective. . . ."

"You may be sure that they are not spending such effort and resources unless they believe firmly that it can be justified in terms of world domination. Manned spacecraft can be used, in the hands of aggressors as well as in the hands of defenders, for active military purposes. In the hands of Communists they can also be used for blackmail purposes."

**Trevor Gardner**, chairman of the board and president of Hycon Manufacturing Co., former Air Force Assistant Secretary for R&D and joint author of the recent and still secret Air Force Gardner Report on military uses of space:

"We cannot afford to continue to lag in the field of military space development. Our President has already com-

# illion

f various program levels and alternatives.

Then the military services were directed to submit their program proposals for FY '63 along with plans for the next five years, and each service reviewed and commented on the proposals of the other two.

It was on the basis of the proposals and comments that McNamara made his program decisions.

• **Figures still in mind**—No one—least of all, Hitch—would contend that the program decisions were made without thought of the total budget which they would necessarily produce.

McNamara has been in informal contact with the Bureau of the Budget and others in the Kennedy Administration on the question of the FY '63 budget, and he certainly has some idea of the approximate size that would be acceptable.

By the same token, the military services certainly had a general idea of budget totals in mind while drawing up program proposals. And, as one official put it: "The services used to submit very large budgets, now they submit very large program proposals."



**Charles J. Hitch**

*COMPTROLLER changed DOD budget making.*

But the emphasis is now considered to be on programs—not dollar totals that can be trimmed 5 or 10% with the reprogramming figured out later.

McNamara and Hitch are expecting few program changes during the budget review with the White House unless they are forced by such things as a worsening of the Berlin crisis or the outbreak of new troubles in Southeast Asia or the Middle East.

If the international situation should deteriorate further, program levels are expected to rise and carry the budget

with them to considerably higher levels.

However, to date the planned FY '63 additions to the Kennedy FY '62 defense programs are not expected to add more than several billion dollars to the cost of continuing present program levels in the new fiscal year.

Total defense expenditures for FY '62—including some \$225 million for civil defense—are expected to run to about \$47 billion—a \$4-billion increase over spending in FY '61.

Pentagon spending in FY '63 even without any new increase in programs is expected to rise to nearly \$50 billion. The cost of increases now planned—possibly as much as \$2 billion—must come on top of the \$50 billion that is already built into the defense budget.

• **Fiscal confidence**—The prospect of the defense budget rising from the low \$40 billions to the low \$50 billions in one year does not alarm Hitch. He sees no threat to the economy, as did many in the Eisenhower Administration.

Hitch put his view of the subject bluntly in his book, "The Economics of Defense in the Nuclear Age."

"... Growth of the economy of the United States would by itself permit increases in defense outlays up to about \$10 billion per year. If we wished to do so, therefore, we could raise the annual defense budget by \$20 billion in two years' time without cutting aggregate consumption, investment or civil government programs. . .

"In brief, our national security budget is not near any physical limits. . ."

mitted the nation to a major national effort in space exploration—the lunar landing and return program. Our national leaders are now confronted with the need for a similar commitment with respect to U.S. military space superiority. . .

"In view of recent Soviet behavior concerning resumption of nuclear tests, a real possibility exists that a forthcoming test in this new ICBM series could involve the explosion of a giant nuclear warhead, instead of a dummy payload.

"In the face of these two test programs and their grim implications of large thermonuclear bombs in orbit in ICBM's, we must solemnly re-examine our military defensive and offensive space plans and urge our national leaders to permit us to embark on a new and invigorated military space program.

"We must also re-examine our civilian space program (particularly the lunar program) so that we will gain the maximum military yield. . .

**Gen. Bernard Schriever**, commander of the Air Force Systems Command:

"I believe the threat to our national security discussed by the other panel members is a major cause for concern. The development of effective functional capabilities in space will be a principal factor in the continuing struggle for leadership of the world. . .

"There is no short cut to the creation of a team of dedicated and experienced men with a tradition of accomplishment. The Air Force has a highly competent team trained in the skills required to develop the necessary military capabilities in space. These people are accustomed to working with the sense of urgency necessary in programs vital to the national security. . .

"The United States has been notably slow to recognize the military application of new inventions. This was an adequate philosophy for the days when oceans were real barriers and gave us time to mobilize after the outbreak of war. But today, technological surprise

could be fatal.

"Two of the most significant technical achievements of this century—the airplane and the liquid-fueled rocket—are American inventions. Yet in each case their first military application was made by other nations."

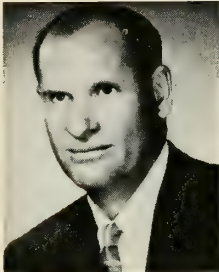
**Rep. Emilio Q. Daddario** (D-Conn.), member of House Space Committee:

"People cannot believe that the Russian space effort, once fully developed, will not be used for military purposes. . .

"I have for some three years now heard conflicting and diverse views as to how this threat should be met. Indeed, I have often heard it pronounced that the Russians have no intention to use their space capabilities for military purposes. If we were to follow that school of thought, we could one day wake up to a sky full of armed satellites hovering impregnable in space over the critical centers of the free world, and from that moment freedom would be lost forever. . ."



# NASA Realigns to Push Moon Program



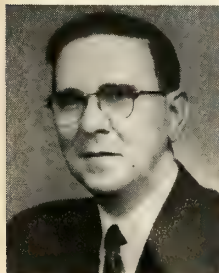
Thomas F. Dixon  
Deputy Associate Administrator



Dr. D. Brainerd Holmes  
Director, Manned Space Flight



Dr. Homer E. Newell  
Director, Office of Space Sciences



Ira H. Abbott  
Director, Office of Advanced Research

**Super management group established to run Apollo called similar to Navy's Polaris direction—but with one major difference; Holmes outlines functional approach to job**

by Hal Taylor

THERE'S NO SLOT for a "Moon Boss" in NASA's new organizational setup, but space agency officials declare that D. Brainerd Holmes, director of manned space flight programs, will have the authority to get the job done.

Dr. Robert C. Seamans Jr., NASA's assistant administrator, says, "he (Holmes) is the closest thing to a Czar in the *Apollo* program."

A quick look at NASA's new organizational chart—effective Nov. 1—leaves the clear impression that the triumvirate of Seamans, Administrator James E. Webb and Deputy Administrator Dr. Hugh L. Dryden will be the real powers behind the U.S. moon program.

This is denied emphatically by Seamans.

"The only way the program can work," he declares, "is to define Holmes' responsibility and give him the ball. I can assure you, that is how we'll operate."

• **Functional philosophy**—Holmes, general manager of RCA's Major Defense Systems Division, was named to his new post Sept. 20 (M/R, Sept. 25, p. 10) and will take office Nov. 1.

He outlined his own management philosophy this week in an interview with *MISSILES AND ROCKETS*. He said he usually favors a functional (launch vehicle group, spacecraft group, etc.) arrangement as a technique.

"First, I work out a logical organization without regard to people," Holmes said. "Then I modify it to fit the personnel available." This is the approach he took as project manager for the vast organization employed on BMEWS (Ballistic Missile Early Warning System).

Holmes feels his job is "to direct a program management group which will coordinate NASA resources for, control the budget for, and be responsible for all U.S. efforts to get a man in space."

Shortly after the Holmes appoint-

ment, NASA announced organizational and personnel changes designed to give the space agency a managerial capacity to run all future U.S. manned civilian flight programs.

• **Realignment**—Major changes under the new setup include:

—Thomas F. Dixon, director of the office of Launch Vehicle Programs, to Deputy Associate Administrator. In addition to serving as Dr. Seamans' chief assistant, Dixon will be responsible for development of launch vehicles smaller than *Saturn*-class boosters. The office of Launch Vehicle Programs was abolished.

—Dr. Homer E. Newell, Deputy Director, Office of Space Flight Programs, to director of the new Office of Space Sciences.

—Ira H. Abbott, director of the Office of Advanced Research Programs, to director of the new Office of Advanced Research and Technology.

—Dr. Abe Silverstein, director of the Office of Space Flight Programs, to director of the Lewis Research Center, Cleveland, Ohio.

—Robert R. Gilruth, director of the Space Task Group, Langley Field, Va. and NASA's *Mercury* program, to director of the new Manned Spacecraft Center, Houston, Tex.

—A new Office of Applications established, with a director still to be named.

• **Special twist** — Both government and industry leaders advised NASA that the only way to beat the Russians to the moon was to set up a "Special Projects" type agency responsible only for the *Apollo* program, with one man in control of every facet and key decision.

Webb decided instead on a refinement of this approach. Killing the idea of a special projects office, he decided to set up a super management group which would have to report to Seamans, Dryden and himself (M/R, Jan. 17, p. 56).

The new Office of Manned Space Flight Programs will not only run the missiles and rockets, October 2, 1968

pollo program, but also be capable of growth and have a built-in capacity to manage any future U.S. manned flight programs. At the same time, Webb ordered that the Directors of NASA's various research centers would also have report directly to Seamans.

According to Seamans, the new organizational structure is necessary because "manned space flight is a tremendously large technical endeavor which will require a large amount of effort and work at all NASA centers."

"This is the only way," he continued, "that we can draw on all the resources to get the job done."

The center directors will have a say in NASA's policy planning for future space programs, he said. They will not be drawn into the program management of current programs, he added, and they will not be able to second-guess the decisions of the four program offices.

Holmes' new directorate will be responsible for overall systems engineering and evaluation for the various manned space flight projects, including spacecraft, all launch vehicles of Saturn and above classes, ground support equipment, tracking stations and communications network.

Its first job will be to define the real objectives of manned space flight including lunar exploration and earth-orbiting flights. Then it will have to

block out the tasks and assign the work to the centers.

• **Like Polaris, but**—Seamans said the new NASA organization gives the Manned Space Flight Office essentially the same makeup as the Special Projects Office of the Navy Polaris program.

There is one main difference, however. Adm. William F. Raborn, head of the Polaris program, could go directly to industry to award contracts. Under the NASA arrangement, the various research centers will still be responsible for contracting.

It is also apparent that many of the basic decisions in the Apollo program will be made before Holmes takes over on Nov. 1. These include such things as the size of boosters, spacecraft, and whether rendezvous or direct descent will be used in the moon program.

Under the reorganization, the other three main program office responsibilities line up like this:

—Office of Applications will have control of the communications and meteorological satellite programs.

—Office of Space Sciences will be responsible for unmanned scientific investigation of space, the moon and the planets—including the Surveyor, Ranger, Mariner, Orbiting Geophysical Observatory, Orbiting Solar and Astronomical Observatory satellites, and all sounding rocket programs.

—Office of Advanced Research and

Technology will control the Rover nuclear energy program, SNAP and the development of advanced propulsion.

—Office of Manned Space Flight will have a top management structure including a systems engineering group, a launch vehicle organization to develop the Saturn-and-above boosters, and a spacecraft group which will draw heavily on the Mercury Program staff.

• **To be resolved**—While the NASA reorganization has been tied up fairly neatly, there are some loose ends:

—No decision has been made yet as to who will do the systems engineering in the Manned Space Flight Office. Under the Polaris program, an industrial contractor, Vitro, was given the job. NASA officials favor having the new group do their own systems engineering, using "in-house" personnel. Space agency officials hope to get the aid of the Defense Department in staffing the group.

—No one has been selected to head the Office of Applications. NASA officials reportedly favor an industrial executive who has experience in the commercial communications field. It is also understood that NASA Administrator Webb would like John J. Burke, Jr., executive vice president of the Siegler Corp., for the post. Burke is scheduled to take a temporary consultative position with NASA before finally deciding whether he wants the job. ■

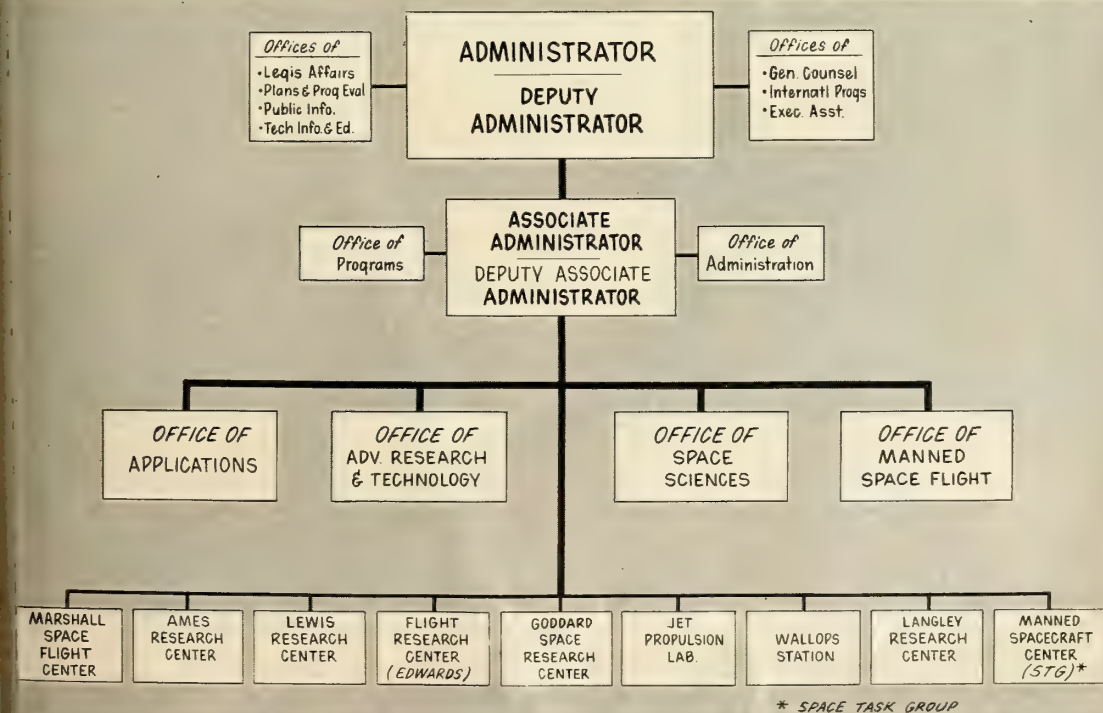


CHART SHOWS how NASA has reorganized to stress key programs—especially Apollo.



# NAA by Far Biggest NASA Contract

**McDonnell was runner-up; total procurement reached \$756,000,000; small firms won 15% of money spent**

NORTH AMERICAN Aviation, Inc., top NASA contractor in Fiscal 1961, received more than one and a half times as many NASA procurement dollars than its closest competitor, McDonnell Aircraft Corp., according to the procurement report just released by the space agency.

NAA cornered 18% of the direct awards over the past year—a percentage representing some \$75 million in procurement actions. McDonnell, its closest competitor, received some \$41.8 million—10% of the direct awards.

Other highlights of the procurement report:

—NASA procurement for FY '61 totalled \$756 million, representing some 94,000 procurement actions.

—Of this total, some 56% were

placed directly with business firms, 12% under NASA's contract with Jet Propulsion Laboratory, 3% with nonprofit institutions or organizations and 29% with or through other government agencies.

—Direct awards to Small Business totalled about 15% and, of the awards to large businesses, it is reported that approximately 20% of these contracts went to small businessmen.

—Approximately 32% of NASA procurement actions were placed in substantial labor surplus areas.

• **Extent of competition**—Of the \$423.3 million in direct contract awards by NASA, approximately 9% were placed through formal advertising for competitive bids, 56% through competitive negotiation and 35% by non-competitive negotiation. The high percentage of negotiated contracts results from the fact that much of NASA procurement is for research and development effort on a cost-reimbursable basis. This type of contract is not permitted in formally advertised procurement.

During FY '61, Source Evaluation

Boards — composed of government scientists and engineers versed in the technical details of the proposed procurement and representatives of government business management staffs—were used in connection with the award of 18 new contracts, totalling about \$3 million.

By far the majority of NASA awards (83%) were placed on a cost-plus fixed-fee basis. About 16% of the awards were on a firm fixed-price basis while the remaining 1% included: actions on cost (no fee), cost sharing fixed-price-redeterminable, fixed-price-incentive and time and materials contracts. However, since awards under \$25,000 are not included, the fixed price category, as a percentage of the whole, is understated.

On the basis of estimated costs, the CPFF contract yielded the contractor a fee of from six to eight percent with the bulk of the fees (65%) averaging between six and seven percent.

• **Non-profit contract awards** — Of the \$24.5 million awarded to non-profit institutions or organizations, \$13.7 million covered research contracts. A

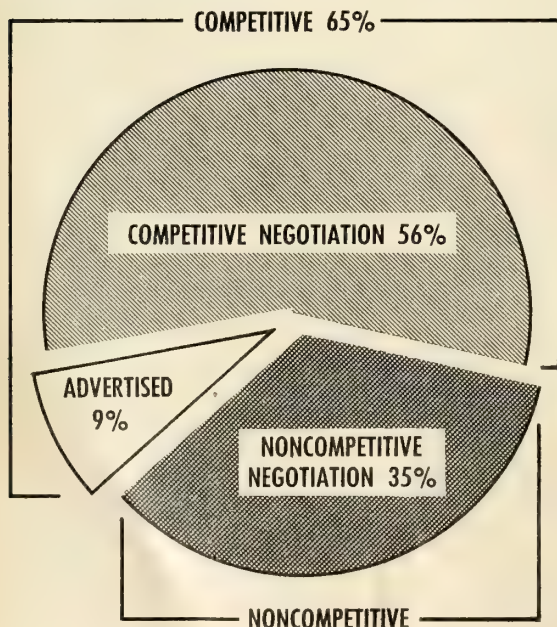
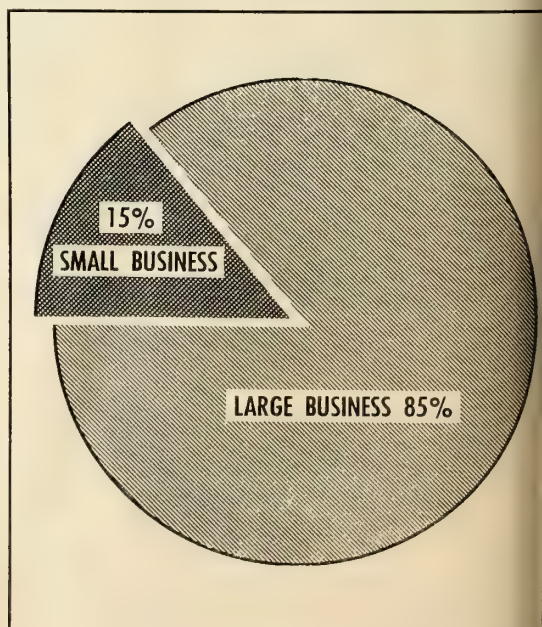


CHART SHOWS 35% of awards negotiated noncompetitively.



SMALL BUSINESS won 65% of contracts, 15% of dollar total

# FY '61

## Twenty-Five Contractors Listed According to Net Value of Direct Awards Fiscal Year 1961

| Contractor                       | Net Value of Awards  |                                     |                    |                  |
|----------------------------------|----------------------|-------------------------------------|--------------------|------------------|
|                                  | Thousands of Dollars | Percent of Total Awards to Business | Cumulative Percent | No. of Contracts |
| <b>Total</b>                     | <b>\$423,294</b>     | <b>100</b>                          |                    |                  |
| NORTH AMERICAN AVIATION INC.     | 75,009               | 18                                  | 18                 | 21               |
| McDONNELL AIRCRAFT CORP.         | 41,843               | 10                                  | 28                 | 4                |
| DOUGLAS AIRCRAFT COMPANY         | 30,698               | 7                                   | 35                 | 8                |
| WESTERN ELECTRIC COMPANY         | 26,609               | 6                                   | 41                 | 3                |
| SPACE TECHNOLOGY LABORATORIES    | 13,098               | 3                                   | 44                 | 11               |
| CHRYSLER CORPORATION             | 12,922               | 3                                   | 47                 | 9                |
| GRUMMAN AIRCRAFT ENG., CORP.     | 11,168               | 3                                   | 50                 | 3                |
| THE HAYES CORPORATION            | 10,278               | 2                                   | 52                 | 4                |
| GENERAL ELECTRIC COMPANY         | 9,197                | 2                                   | 54                 | 30               |
| CHANCE VOUGHT CORPORATION        | 8,773                | 2                                   | 56                 | 12               |
| RADIO CORPORATION OF AMERICA     | 8,580                | 2                                   | 58                 | 31               |
| BROWN ENGINEERING CO., INC.      | 6,680                | 2                                   | 60                 | 2                |
| BENDIX CORPORATION               | 6,481                | 2                                   | 62                 | 16               |
| AEROJET-GENERAL CORPORATION      | 6,286                | 1                                   | 63                 | 14               |
| LOCKHEED AIRCRAFT CORPORATION    | 3,335                | 1                                   | 64                 | 13               |
| MINN. HONEYWELL REGULATOR CORP.  | 2,730                | 1                                   | 65                 | 14               |
| NORAIR ENGINEERING CORPORATION   | 2,512                | 1                                   | 66                 | 3                |
| GENERAL DYNAMICS CORPORATION     | 2,135                | 1                                   | 67                 | 17               |
| FLEXONICS CORPORATION            | 2,128                | 1                                   | 68                 | 2                |
| BALL BROTHERS RESEARCH CORP.     | 2,025                | *                                   | 68                 | 4                |
| UNITED ENG. & CONSTRUCTORS, INC. | 2,000                | *                                   | 69                 | 1                |
| COLLINS RADIO COMPANY            | 1,994                | *                                   | 69                 | 3                |
| ARTHUR VENNERI COMPANY           | 1,969                | *                                   | 70                 | 1                |
| CARL N. SWENSON COMPANY          | 1,835                | *                                   | 70                 | 3                |
| AMPEX CORPORATION                | 1,685                | *                                   | 70                 | 20               |
| <b>OTHER</b>                     | <b>131,324</b>       | <b>30</b>                           | <b>100</b>         |                  |

\* Less than one half of one percent

roximately 66% of the actions were on a cost (no fee) basis, 24% on a cost-plus-fixed-fee, 8% on fixed-price and the remaining 2% on time and materials and labor hour contracts. The PFF award yielded an average fee of 01%.

The remaining \$10.9 million of the awards to non-profit organizations represented research grants.

The leading nonprofit institutions for FY '61 were: MIT, U. of Michigan, U. of New Mexico, U. of Alaska, Cornell Aeronautical Lab, Rand Corp., Battelle Memorial Institute, Stanford Research Institute, Princeton, and the State University of Iowa.

The Jet Propulsion Laboratory, operated for NASA by the California Institute of Technology, received approximately \$86 million during the year. These funds provided the basis both for the laboratory's research efforts and for improvement, modernization and expansion of JPL facilities.

• **Awards to government agencies**—Of the \$221.6 million placed with or through other government agencies, approximately 64% went to the Air Force for the *Saturn*, *Centaur*, *Atlas* booster and *Agenda* programs. The Departments of the Army and Navy, the Atomic Energy Commission and Commerce Department won other awards.

The philosophy behind this large amount of procurement through DOD was to avoid duplication of effort and to achieve effective utilization of both agencies' resources.

During the past year NASA has reverted to letter contracts in 57 instances, with a total dollar value of about \$55.1 million. Of these only nine had been completed by the end of the fiscal year; 15 contracts, with a total dollar value of \$46.6 million, had not been finalized.

• **Procurement by R&D program**—Approximately 85% of NASA's procurement during the fiscal year was funded from its R&D appropriation. Vehicle development received 30% of its total for the development, fabrication and launching of space vehicles including the *Scout*, *Delta*, *Centaur* and *Saturn* vehicles. The *Saturn* and *Centaur* accounted for 92% of the procurement in this area. Scientific investigations of space, utilizing sounding rock-

ets, earth-orbiting satellites and lunar and planetary probes, consumed 17% of the R&D procurement dollar, while Space Propulsion Technology and Manned Space Flight received 13 and 11% of the total R&D procurement.

• **Major awards in FY '61**—During the year, ten new contracts of over \$5 million each were awarded directly to business firms. The total dollar value of these awards was approximately \$87.4 million.

Leading all other contractors was North American Aviation, Inc., with three major pacts for the development of a 200,000-lb.-thrust liquid oxygen-liquid hydrogen engine, the design and development of the H-1 engine for *Saturn* and the fabrication and production of H-1 engines and related spares for the *Saturn* program.

Other leading industrial concerns were Chrysler Corp., Hayes Aircraft Corp., STL, Aerojet, Chance Vought, Grumman and Brown Engineering.

Carry-over contracts for work already in progress were awarded to five

major business firms. Again North American led with an award of \$73.9 million for further work on the 1.5-million-pound-thrust engine. McDonnell received \$41.6 million for continuing work on the *Mercury* program, while Western Electric was awarded \$26.5 million for maintenance of the *Mercury* tracking and ground instrumentation system. Douglas received two awards: \$22.4 million to design, develop and test the *Saturn S-IV* stage vehicles and \$7.8 million for design, development and launch of *Delta* three-stage vehicles.

• **Leading states**—The four states receiving the largest share of NASA procurement awards, and total dollar value of these pacts, were: California, \$148.7 million; New York, \$43.9 million; Missouri, \$42.5 million; and Alabama, \$37.1 million.

Of NASA's direct awards of \$25,000 and over, \$92 million, or 32%, were placed in areas which were designated by the Department of Labor as substantial labor surplus communities. ■



# nasa's apollo program/\$20 billion for industry



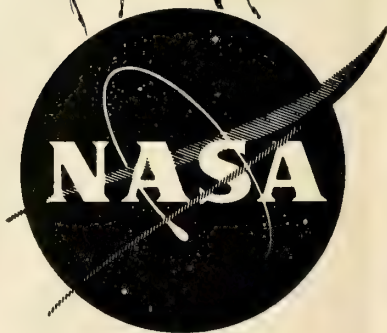
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# Technical Countdown

## ELECTRONICS

### EIA Attacks NASA Patent Policy

NASA's proposed patent policy, if used generally by all Federal agencies, would effectively make the government a total economic dictator and end the free enterprise system, says an Electronics Industries Association official. The proposal basically covers the grant of exclusive licenses to individual manufacturers for the use of NASA patents. Elmer J. Gorn, chairman of EIA Patents Committee, told a recent NASA hearing on patent regulations that the only workable policy is to grant the people of the United States "... the right to practice inventions covered by U.S.-owned patents freely, unconditionally, and without charge."

### Rugged Missile Programmer Developed

A new solid-state digital timing programmer, designed for missile arming and fuzing control, provides an accuracy of better than 0.1% even under extreme environmental conditions. Built by Tempo Instrument Inc. for Army Ordnance Corps' Picatinny Arsenal, it has operated in temperatures from -65 to 165°F, withstood vibrations up to 50-g at 2 kc, and survived shock and accelerations to 100-g, the company says. Poorest timing error over the longest test period (109.9 sec.) was only 0.024%—or 27 msec.

## SUPPORT EQUIPMENT

### Soviets Develop Pneumatic Computer

A miniature pneumatic computer—capable not only of performing simple arithmetic operations but also of solving integral and differential equations—has been developed by Soviet scientist, according to a report in the *Ekonomicheskaya Gazeta*. The computer consists of a set of metallic washers with diaphragms made of rubberized linen. The washers form miniature chambers which receive the inflow of compressed air. The operation of the device is controlled by means of stop-cocks built into the tubes carrying the compressed air.

### Vostok II Communications Described

The system used for communication between *Vostok II* and earth, according to *Izvestia*, consisted of two AM, short-wave telegraph-telephone transmitters operating in parallel at 15.765 mc and 20,006 mc through special separation filters (duplex) with a common antenna. A third transmitter—an FM, 143.625-mc device operating within a  $\pm 30$ -kc bandwidth with a special antenna—was used during the vehicle's flight over the USSR.

### Phased-array Radar Advanced

Phased-array radar evaluation, performed by Sylvania at Waltham, Mass., as part of its work in ARPA's Project Defender, has created new concepts of long-range missile detection and tracking. The experimental system CODI-HASE (Coherent Digital Phased Array System) is believed to offer a simpler, more efficient, less costly approach to rapid simultaneous search-track of multiple missile targets. The heart of the technique is its use of digital computer circuits for radar return signal processing and control. Sylvania says the system has superior accuracy and resistance to electronic countermeasures.

Missiles and rockets, October 2, 1961

## Electrothermal Rock-crusher Feasible

Recent test reports by General Electric and the Montana School of Mines show that high-energy radio-frequency power can be used to break rock faster and more economically. Called electrothermal forcing, the technique makes use of water of crystallization as an r-f conductor between electrodes attached to the rock. The resulting thermal stress along the path of conductivity will split or even shatter rock (depending on the applied force) in seconds, whereas conventional techniques may take days. An r-f current from 20-40 mc and about 25 kw of power is sufficient, the report says.

## ASW & SEABORNE ENGINEERING

### ASW Drone Nears Completion

First units of the airborne/shipboard digital communications system for the Navy's Drone Anti-Submarine Helicopter (DASH) have just been delivered to Gyrodyne Co. by Motorola. Gyrodyne is developing DASH, which will be capable of seeking out and destroying enemy submarines. The Motorola system provides remote radio control and digital data processing and computation for maneuvering the DSN-3 drone for weapons release.

## PROPULSION

### Orbiting "Gas Stations" Suggested

An analysis of the fuel requirements for a flight to the moon and back, and the resultant weight of the take-off vehicle, has led one Soviet scientist to suggest the use of satellites as intermediate fueling points. Writing in the *Ekonomicheskaya Gazeta*, N. Varvarov considers the projected velocity requirements of various phases of the lunar mission—and concludes that the launch vehicle weight would be an "impossible" 10,000 tons.

## ADVANCED MATERIALS

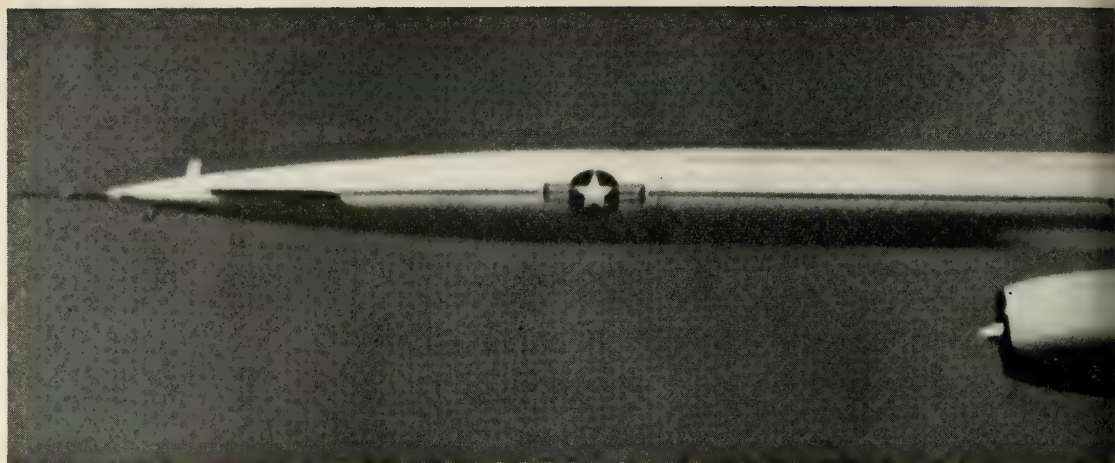
### Solution to Corrosion in Offing?

A new technique for studying surface reactions on materials, developed by scientists at Bell Telephone Laboratories, gives a detailed view of atomic arrangements in such reactions. Low-energy electrons are diffracted from a surface and accelerated to a fluorescent screen, using a strong electric field. The pattern produced gives the arrangement of the first monolayer of surface atoms. The technique opens the door to better understanding of such surface phenomena as catalysis and corrosion, Bell reports, and should permit revolutionary advances.

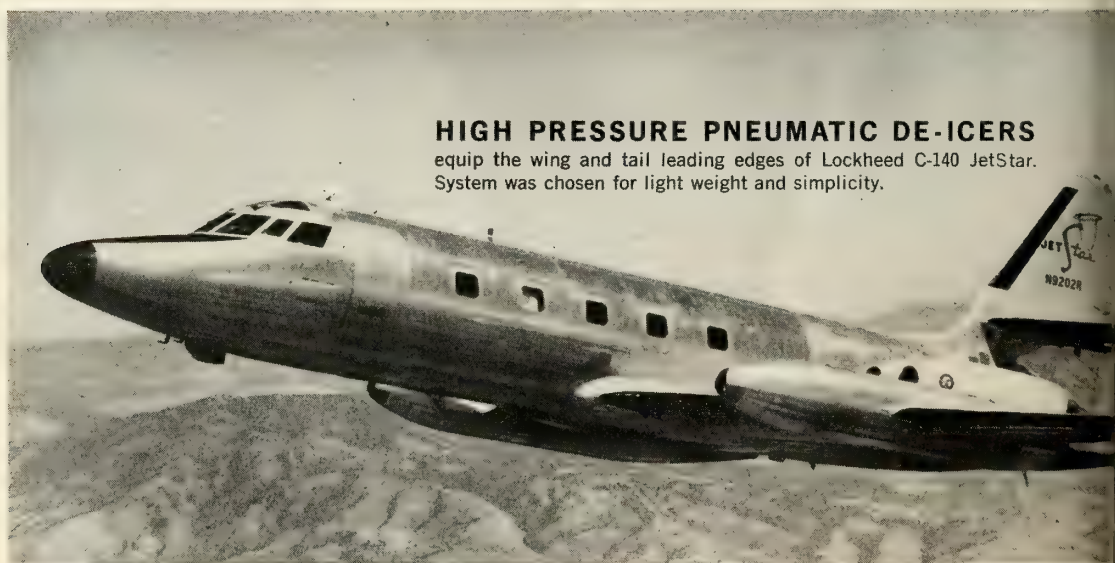
### Bell Rings Twice

Another advance revealed by Bell Labs is the use of yttrium iron garnet (YIG) in microwave applications. Recent studies indicate YIG is substantially better than conventional ferrites. Both can be employed for microwave transmissions with low loss and as isolators for one-way transmission lines, among other uses. Both materials are ferrimagnetic, but YIG is a better electrical insulator. Further, YIG resonance-peak linewidth (0.14 oersted at 20°C and 6000 mc) is narrowest ever reported for any ferrimagnetic material.



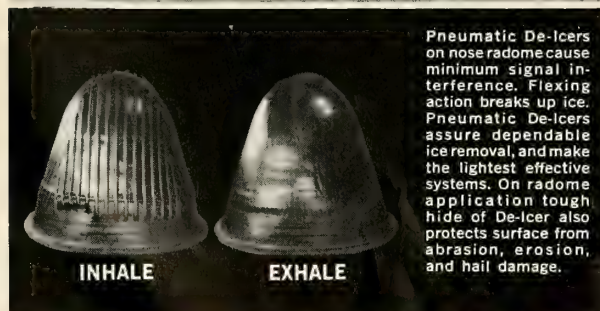


# B.F. Goodrich develops versatile systems for **ICE PROTECTION**



## HIGH PRESSURE PNEUMATIC DE-ICERS

equip the wing and tail leading edges of Lockheed C-140 JetStar. System was chosen for light weight and simplicity.

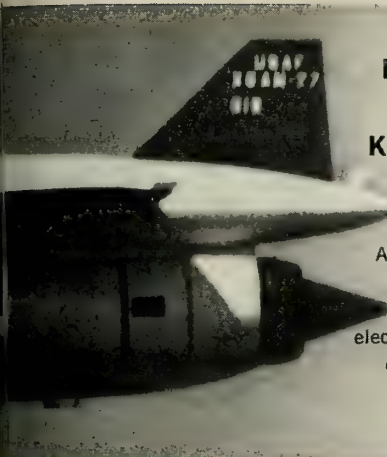


Pneumatic De-Icers on nose radome cause minimum signal interference. Flexing action breaks up ice. Pneumatic De-Icers assure dependable ice removal, and make the lightest effective systems. On radome application tough hide of De-Icer also protects surface from abrasion, erosion, and hail damage.



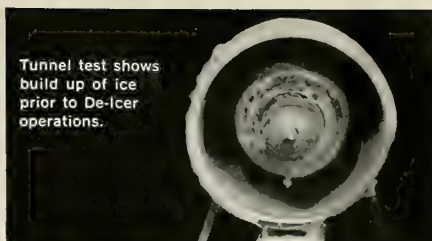
**FLYING TV** specially equipped casts. Two pneumatic 23-foot antenna.

**ANTENNA** is kept ice-free on the DC-6AB used for educational broadcasting. Pressure is cycled in spanwise tube

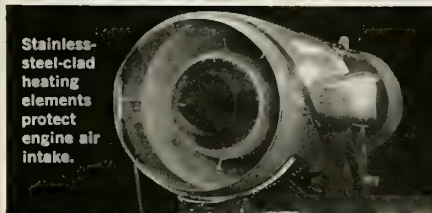


## ELECTRO-THERMAL DE-ICER SYSTEMS KEEP "HOUND DOG" NOSE WARM

To keep this North American Aviation missile's engine ready for instant launching despite freezing conditions, BFG electro-thermal units are installed on the nose cone, supporting struts and ram air probes.



Tunnel test shows build up of ice prior to De-Icer operations.

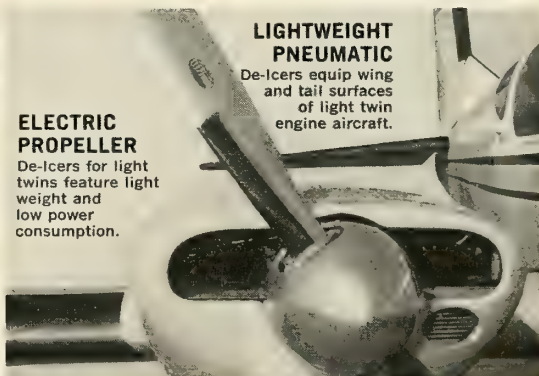


Stainless-steel-clad heating elements protect engine air intake.

By introducing the first pneumatic De-Icers for aircraft over thirty years ago, B.F. Goodrich has developed a broad capability in ice protection systems: *Pneumatic De-Icers* are used on high performance aircraft like the Lockheed C-140 JetStar...and designed as lightweight systems for small twins. *Metal Clad Electro-Thermal De-Icers* can be adapted to airfoil shapes, and in many cases can serve as structural members. *Clad Rubber* is adaptable to fit complex curves or odd shapes for localized heating. *Reinforced plastic* De-Icers, integrally heated, are available for applications not subject to severe abrasion. Whatever your requirements in eliminating or controlling ice bring them to BFG...the leader in De-Icing. For information contact BFG MR-10, B.F. Goodrich Aerospace & Defense Products, a division of The B.F. Goodrich Company, Akron, Ohio.



**"HAIL-SAFE" DE-ICING** is provided on empennage of General Dynamics/Convair 880 by BFG Cladheat electro-thermal De-Icers. Stainless steel skin withstands abrasion from rain, dust, even hail at high cruising speeds. Six-foot Cladheat sections are bonded to leading edges to form a smooth, integral airfoil.

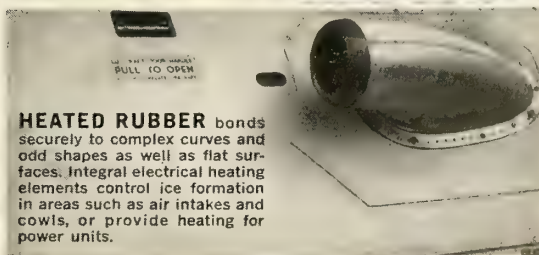


### ELECTRIC PROPELLER

De-Icers for light twins feature light weight and low power consumption.

### LIGHTWEIGHT PNEUMATIC

De-Icers equip wing and tail surfaces of light twin engine aircraft.



**HEATED RUBBER** bonds securely to complex curves and odd shapes as well as flat surfaces. Integral electrical heating elements control ice formation in areas such as air intakes and cowls, or provide heating for power units.



aerospace and defense products



# STL/Bell Draco Could Fill Pre-Saturn

An exclusive M/R report on fluorine/hydrogen upper stage being proposed for mating with Titan II

by Frank G. McGuire

LOS ANGELES—A fluorine-hydrogen upper stage being developed for use with *Titan II* may close the increasingly serious gap between *Atlas*-boosted vehicles and the upcoming *Saturn* launches.

The hypergolic propellant mixture would be employed in an upper-stage configuration designed by Space Technology Laboratories, Inc. and powered by an engine from Bell Aerosystems Company.

The upper stage, designated *Draco*, is designed for rapid transition from drawing-board to hardware, and uses a multiple-space-restartable engine closely approximating that used in the *Agna* satellites.

Ignition has been the primary cause of trouble with *Centaur*, and although *Draco* would not be operationally ready for space missions as soon as *Centaur*, the basic design indicates that its hypergolic propellants would vastly reduce ignition problems.

STL says the *Draco* would have over 440 seconds specific impulse and approximately 30,000 lbs. of thrust, and could be launched a little over two years after a go-ahead order. (*Centaur* has 425 seconds of specific impulse and 30,000-lb. thrust level, using two engines.)

Although no commitment has been made to push *Draco*, the delays currently afflicting *Centaur* (M/R, Sept. 4, p. 12) may force such a decision soon.

The single-engined stage can be used with *Atlas*, *Titan II*, or *Saturn C-2*, but is obviously intended to enhance the potential of *Titan II* as a space booster—something the Air Force has not wanted to talk about.

For use with *Titan II*, *Draco* would be 10 ft. in diameter. It would be approximately 25 ft. long if single bulkheads were used for separating the propellant tanks. If double bulkheads were used, to provide room between the tanks for insulation to make the propellants space-storable, the length would be about 28½ ft.

These dimensions generally vary, depending on the booster to be used and the mission.

A Jet Propulsion Laboratory study conducted to determine the optimum combination of upper-stage liquid propellants for space boosters concluded that fluorine and hydrogen were the best. The independent study, having no connection with *Draco*, generally concurs with all STL statements about *Draco's* advantages and abilities.

The STL/Bell team says it has solved all problems of storage, transfer materials and operating procedures connected with fluorine/hydrogen, one of the highest energy combinations available in stable chemical systems.

The engine, a pump-fed design, would be manufactured and tested by Bell, and the remaining stage subsystems by STL. The complete propulsion system would be tested at Edwards AFB, Calif. The team points to a record of 600 rocket engine firings in which Bell used fluorine with a variety of fuels.

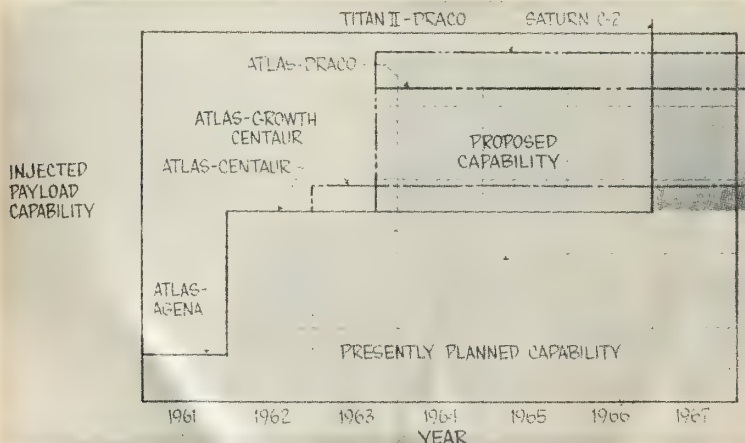
• **Capabilities**—With a total impulse of 16,500,000 lb./sec., *Draco* used with *Titan II* could put at least 3000 lbs. into 24-hr. equatorial orbit about the same mission established for the *Advent* communication satellite. Present *Advent* configuration reportedly calls for a weight of more than 1250 lbs., which will strain the ability of *Atlas D/Centaur* even if optimum performance is achieved.

There are similar advantages for most other missions, STL says, and at higher velocity requirements the *Draco* stage can carry half-again to three times the weight of an oxygen-hydrogen stage. There is an added advantage in being able to orbit two or more payloads with one launching.

Although *Saturn* boosters will be available later in this decade, STL points out that some missions will not utilize the maximum potential of these boosters, and that a *Titan II/Draco* booster would be much more economical for a large proportion of missions.

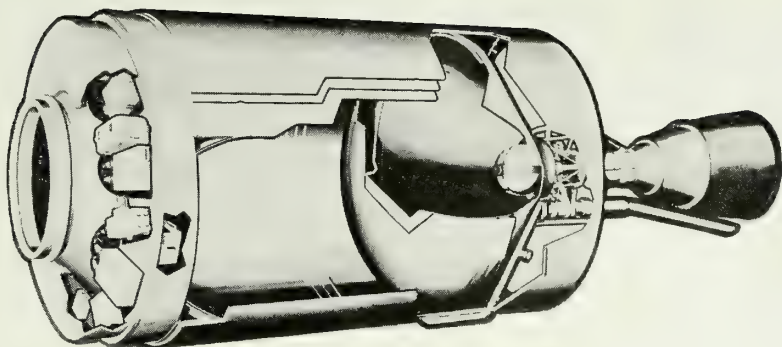
This will go far toward alleviating the payload deficiency expected to become most critical in 1963-1966, when missions beyond *Atlas/Centaur* cannot be planned, according to STL.

• **Vehicle design**—Basically a conventional design, *Draco* uses existing subsystems to a large degree. The greatest departure from current practice is the fluorine propellant. The engine is closely similar, and in some cases identical, to the *Agna* engine. The



LAUNCH VEHICLE capability of *Draco* for soft lunar landing mission.

# Booster Gap



CUTAWAY drawing shows design of Draco.

control and instrumentation subsystems closely resemble those used by STL on the Able and Ablestar stages. The inertial guidance system could be the same used for Centaur.

Guidance of Draco can also be accomplished through the STL-developed system used for Able—or with a combination of the Centaur and Able systems. Cabling and programing equipment for start/stop signals to the Draco engine, or for steering signals to the autopilot, are compatible with both systems.

Either all-inertial or radio command guidance systems can be used.

Gross weight of the stage is about 10,000 lbs. without payload or fairing. Powered by the single, gimbaled, restartable engine, the stage uses a three-axis autopilot to provide attitude commands during powered flight, and a hydrogen peroxide gas jet system during coast periods.

Electrical power supply would come from batteries. Thermal control is maintained by a combination of fixed and jettisonable radiation barriers.

Tandem propellant tanks use a common bulkhead, with the heavier fluorine in the lower tank. Made of welded aluminum alloy, the tanks use internal pressure to stabilize the monocoque cylinder. Baffles are included to prevent propellant sloshing.

Helium pressurization is provided by a completely-immersed sphere in each tank. The pressurization in the hydrogen tank is augmented by gaseous hydrogen passed through a heat exchanger at the turbopump exhaust.

A preset schedule governs propellant tank pressurization, so that required pump inlet pressures and pressure differentials between tanks are maintained.

Telemetry, tracking and command control for Draco is similar to that used for Able and AbleStar. Telemetry consists of a wideband IRIG FM/FM system with 10 subcarriers and a one-watt transmitter.

Electrical power is furnished by a main d-c supply in a silver-zinc battery

system. The guidance package obtains a-c power from a static inverter, and the telemetry and range safety systems contain their own battery power.

Ground support equipment and launch site modification have been made as simple as possible to allow maximum use of existing equipment. One segment of the GSE supports the Draco propulsion system and the other segment services the electrical system.

Equipment for the latter includes a checkout van, a telemetry van, launch operating equipment and other miscellaneous support arrangements. The propulsion system support system mainly includes facilities for storage, transfer and disposal of fluorine.

Launch complex modifications include installation of a fluorine storage tank, conversion equipment for introducing gaseous fluorine to propellant tanks and lines for conditioning, a vent gas disposal system for handling fluorine vented during stage loading, and a neutralization system using water fog.

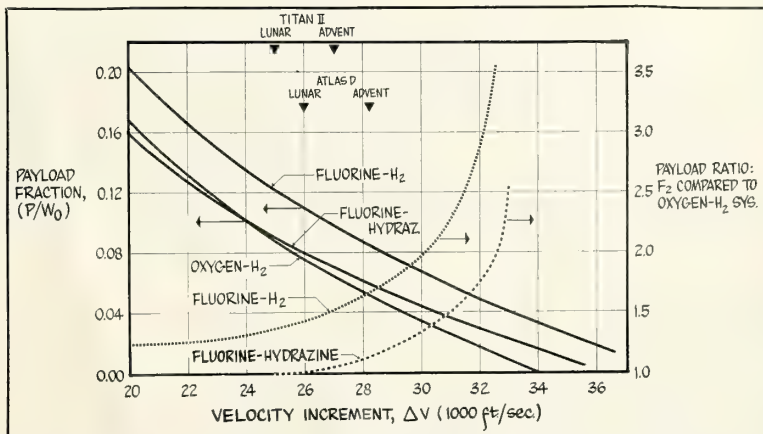
STL/Bell point out that fluorine is now available in large quantities for as little as 90¢ per lb. It is no more toxic than hydrazine, UDMH, or hydrogen peroxide, and is transported by 5000-gal.-capacity tank trucks. It is easily neutralized by water fogs when spilled.

• **Bell engine**—Using experience gained in the Agena program, Bell Aerosystems Co. has come up with a predicted reliability for its Draco engine of 98.3% by the time of the first launch. Agena engine tests, modified to apply to Draco, were used as a basis for prediction, due to the design similarity.

The engine is designed to start and stop in a vacuum, and has a three-restart rating during a total in-flight operating time of over nine minutes. Both propellants are supplied to the combustion chamber by a single turbopump driven by a gas generator. The turbopump also supplies thrust-vector-control hydraulic power through a geared hydraulic pump.

The tubular-walled thrust chamber uses the liquid hydrogen as coolant as far as the 22:1 expansion-ratio point, and the remainder of the exhaust skirt is uncooled to its 45:1 point. The uncooled portion is of columbian alloy.

The engine requires only start/stop controls, with all operations internally controlled by pressure switches and one temperature sensor. Fuel and oxidizer valve sequencing permits nearly simultaneous entry of propellants into the combustion chamber, where hypergolic ignition obviates the need for a separate ignition system. ■



COMPARISON of high-energy chemical stages.





# NORAD ON THE ALERT

## Inputs from BMEWS Provide Instantaneous Missile Data Direct to NORAD Headquarters

From our vast outer defense perimeter, over thousands of miles, to the nerve center of the North American Air Defense Command at Colorado Springs, the most advanced concept of data handling and checkout is being utilized in the BMEWS system. The stakes are high, for the purpose is defense of the North American Continent.

At BMEWS installations operated by USAF Air Defense Command, computers read out missile tracking data from giant radars. This information is simultaneously relayed to NORAD's Combat Operations Center.

The Radio Corporation of America is prime systems contrac-

tor for BMEWS. At the COC, RCA's Display Information Processor computing equipment automatically evaluates missile sightings, launch sites and target areas. By means of data processing and projection equipment installed by RCA and a team of other electronics manufacturers, the findings are displayed on huge, two-story high map-screens in coded color symbols, providing the NORAD battle staff with an electronic panorama of the North American and Eurasian land masses.

The handling of BMEWS inputs at NORAD is an example of how RCA data processing capabilities are assuring the high degree of reliability so vital to continental defense.

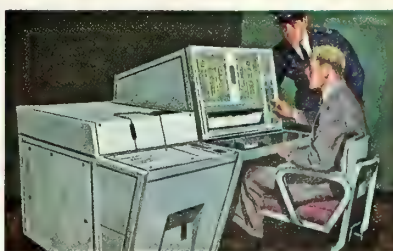




At NORAD Headquarters, RCA computing equipment, the Display Information Processor (control panel shown here) receives sightings data from radar and processes it for automatic readout.



RCA is prime system contractor for the sprawling BMEWS three-site radar network whose probing electronic fingers reach deep into space to provide early warning of missile attacks.



RCA's Automatic Checkout & Monitoring equipment continuously tests and checks performance of portions of the system and alerts an operator when a monitored signal exceeds certain limits.

...ut the defense needs of today a new generation of RCA electronic data processing equipments has been born. For tomorrow's needs RCA offers one of the nation's foremost capabilities in research, design, development and production of data processing equipment for space and missile projects. For information on these and other new RCA scientific developments, write Dept. 434, Defense Electronic Products, Radio Corporation of America, Camden, N. J.



The Most Trusted Name  
in Electronics

RADIO CORPORATION OF AMERICA



# Stratoscope II to Give Clearest Look

**Princeton's Schwarzschild, director of balloon telescope project, says it may revise some basic concepts**

by William Beller

THE AEROSTAT *Stratoscope II* is scheduled to rise 80,000 feet over Minnesota next summer to open the second phase of a major program of balloon astronomy. This work is expected to develop new basic concepts of the universe.

*Stratoscope II* could give astronomers a fantastically clear look at the heavens, one whose images would be resolved to within 0.1 second of arc. This is equivalent to being able to distinguish two golf balls 15 inches apart 500 miles away.

From an astronomer's point of view, this betterment in resolution is critical. The best resolution that earth-bound observatories can obtain, limited as they are by the atmosphere above them, is 0.3 seconds of arc.

Professor Martin Schwarzschild, internationally known Princeton University astronomer in charge of the *Stratoscope* project, told MISSILES AND

ROCKETS that through such high-resolution balloon telescope astronomers hope to learn:

- The dynamics of the birth and death of stars.

- Whether there are holes in Venus' cloud cover.

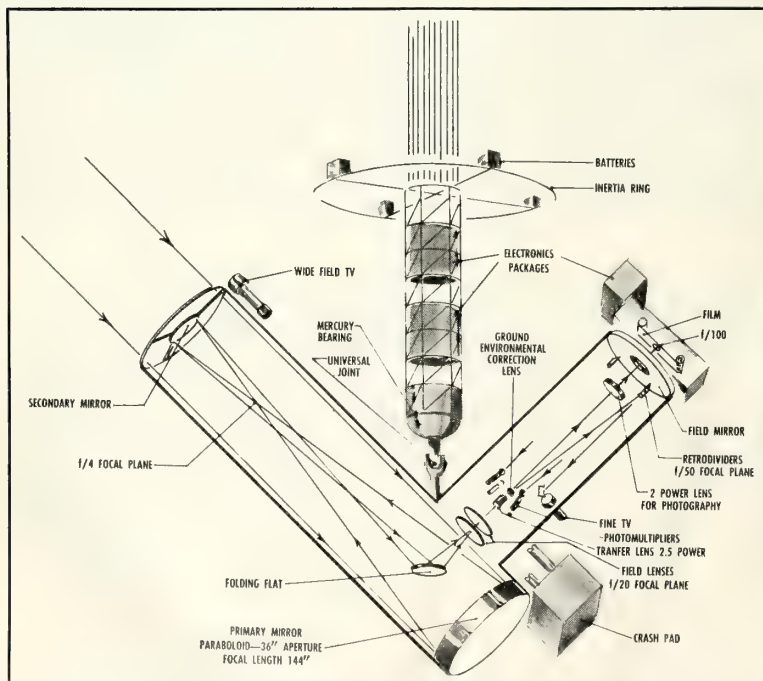
- Whether there are multitudes of small craters on the moon's surface.

- Some of the characteristics of Jupiter's atmosphere.

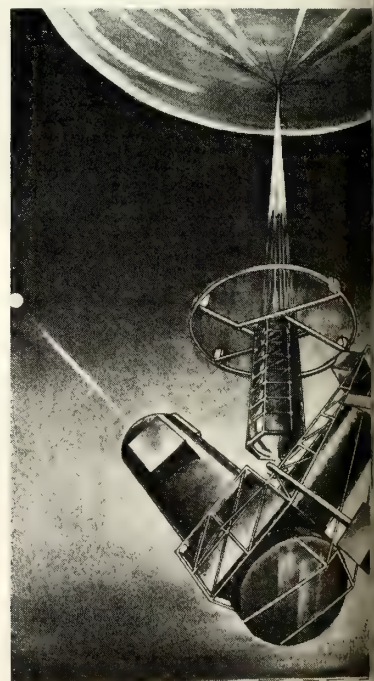
- **Two paths to travel**—*Stratoscope* flights began in 1957 when a General Mills polyethylene balloon lifted a 12-inch-aperture telescope to altitude above New Brighton, Minn. This was the start of Project *Stratoscope I*, which two years later was to yield spectacular photographs of the solar surface.

At first the work was sponsored solely by the Office of Naval Research. In 1959, the National Science Foundation (NSF) and the National Aeronautics and Space Administration became co-

S. KIDD



OPTICAL DIAGRAM of *Stratoscope II*'s 36in.-aperture reflecting telescope



ARTIST'S CONCEPT of telescope.

# Heavens

sponsors, giving the program added impetus.

The telescope on *Stratoscope II* will have a 36-inch aperture, three times the size of the one on *Stratoscope I* and consequently yielding three times the resolution.

It is well known that the measures of a telescope are its resolving power and its light-gathering power. Each is theoretically a function of the telescope's diameter—that is, of the diameter of a reflecting instrument's mirror.

Practically, though, the limit of resolution on earth is reached with a 12-inch telescope. Although a larger one such as the Mount Palomar 200-inch instrument is able to glimpse light from far distance places, it can do no better than the smaller telescope in distinguishing discrete features of heavenly bodies.

The earth's atmosphere not only blurs the images coming into telescopes but also is opaque to ultraviolet light. Therefore, there are two distinct research directions that an astronomer can take once he has an instrument able to rise above a significant part of the atmosphere. He can pursue high definition work as in Project *Stratoscope*, or he can go entirely above the atmosphere and observe the ultraviolet light from the stars. This last direction will be taken when NASA's *Orbiting Astronomical Observatory (OAO)* is launched sometime in 1963.

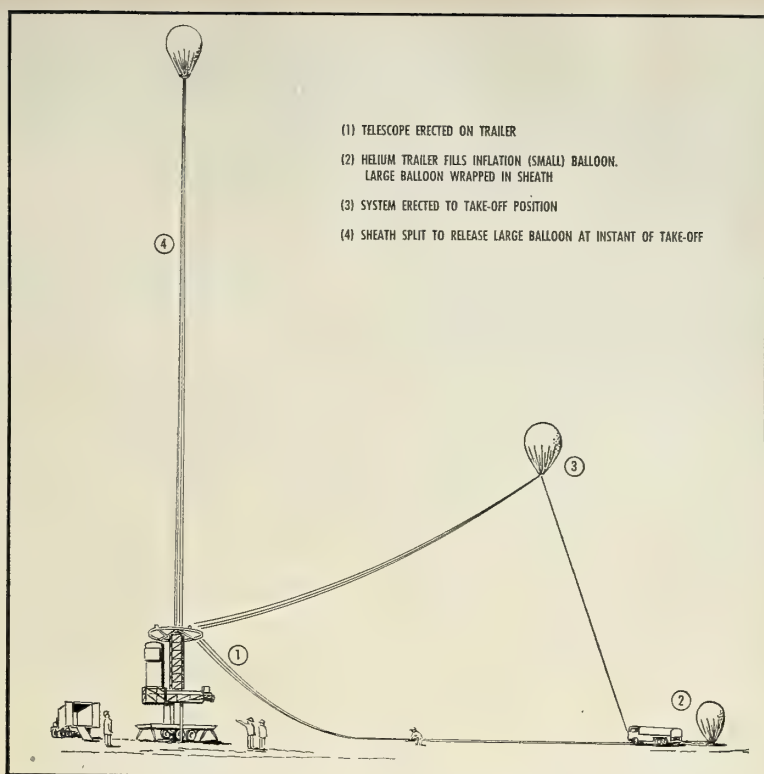
• **How stars are born**—In today's technology, a balloon-suspended telescope has advantages not easily duplicated by a satellite observatory:

—An astronomical body can be studied continuously for a relatively long time—up to an hour.

—Heavy weights can be lifted and they will not have to undergo exceptional stresses during launch. The *Stratoscope II* telescope will weigh over three tons and the total weight to be lifted will be about six tons. (By comparison, the payload of *MA-4*—the unmanned *Mercury* shot of September 13—weighed 2700 lbs. in orbit.)

—The stability of the telescope itself will be within the 0.01 second arc needed to achieve the 0.1 second of arc resolution of the telescopic images.

—A moderate altitude, such as 80,-



**STEPS IN LAUNCHING *Stratoscope II*.** Small balloon is shown inflated, while beneath it the larger balloon is held in a sheath which is ripped off at launch.

000 feet, is sufficient for astronomical observations by visible light; and the altitude is economically reached.

*Stratoscope II* is expected to yield data in several areas.

Astronomers are fairly certain that new stars are being formed in some of the many dense gases or nebulae that lie between stars. The Orion nebula—that famous bright one visible to the naked eye—is the best example, and is also the best nebula for observation.

Understanding of how stars form in such gases is extremely incomplete. Schwarzschild asserts that it is important to know whether these gases are found very evenly and smoothly spread, or whether they are found to be “clumpy”—that is, very dense large clouds imbedded in much less dense gaseous accretions.

The answer to this question is blocked by inability to get sharp pictures from the ground. Yet these dense gas clouds are just on the verge of being resolvable from earth.

The hope is that *Stratoscope II* will get sharp pictures of the brightest and densest portions of the Orion nebula. “We may find that these gases don’t look smooth at all but are highly varying,” says Schwarzschild. “Thus, very sharp pictures of the very bright portion of the Orion nebula are nearly bound

to help us in the theory of the origin of stars.”

Astronomers suspect that normal stars die by ejecting a large part of their total mass in gases. This phenomenon is believed to be observed in the so-called “ring nebula.” What is not understood is the dynamics of how the star does such ejecting: is a smooth shell of gas throw off or gigantic puffs of gas? Astronomers say the answer would be decisive for theoretical work.

Thus, just as *Stratoscope II* can use the Orion nebula to study the dynamics of the birth of stars, so it can use the ring nebula to study the dynamics of the death of a star.

On several occasions, observers have thought they perceived breaks in the cloud layers enshrouding Venus. These breaks, if they existed, were felt to be 0.2 seconds of arc in magnitude, too small to be perceived with certainty with an earth telescope, but large enough for the *Stratoscope II* telescope to resolve.

If such breaks do exist, then the theory of the atmosphere of Venus predicts strong greenhouse effects and these would verify the recent radio measurements which suggest that the surface of Venus is exceedingly hot.

Furthermore, the breaks might also permit us a peek at Venus’ surface.





# How to turn a new face into an old hand

**New employee's learning time cut 75%!  
Production increased 50%!  
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*Interested in Videosonic systems for your operation? Hughes has prepared a special booklet detailing the advantages of Videosonic systems. For your copy, please contact: Manager, Videosonic Systems, Hughes Ground Systems Group, Building 381-M, Fullerton, California.*

Creating a new world with electronics

## HUGHES

HUGHES AIRCRAFT COMPANY





Many observers suspect that there may be a multitude of craters a fraction of a mile in diameter existing on the moon. Schwarzschild says that *Stratoscope II* will try to take some sample photographs of the moon; and because of the step upward in picture sharpness, "this exciting question of miniature craters may be answered."

• **Multi-million-dollar telescope—***Stratoscope II*, which will cost between \$3 million and \$3.5 million, is being managed for Schwarzschild by Vitro Laboratories, Silver Spring, Md. The company's role is to supervise development of the balloon system, devise the launching and recovery methods, and conduct the launches.

The reflecting telescope, which is estimated to cost about \$2.2 million, was designed and developed by the Perkin-Elmer Co., Norwalk, Conn., and is expected to be ready for test late next spring. The instrument is an L-shaped structure, with one arm about 25 feet long and the other nearly 19 feet.

The 36-inch fused-silica optical mirror for the telescope was fabricated by Corning Glass Works, Corning, N.Y. This is the largest fused-quartz blank ever made and, significantly, the most accurately ground mirror ever placed in a large telescope.

Previously, there was no need for high accuracy in a telescope's mirror. One-fifth or one-fourth of a wavelength of green light—which is the middle of the visible spectrum—was sufficiently close to grind the mirror for the resolution the atmosphere permits.

Now, however, the mirror surface has to be a true parabola within 1/20 of the wavelength of green for *Stratoscope II* to get the designed resolution. This means that grinding has to be true within one-millionth of an inch.

Fused silica is used for the mirror, since it is not affected by the sharp temperature gradient the balloon telescope will experience.

• **Piggy-back balloons—**Design of the balloon system involved some tricky problems because of the high order of stability needed by the telescope platform. The scheme now used calls for suspending the gondola on a mercury bearing; in this way, the telescope platform is decoupled from the balloon and motions are not transmitted.

An inertia ring—located above the mercury bearing—can be coupled to



*FUSED-SILICA BLANK* for *Stratoscope II*'s telescope was cast by Corning Glass, precision-ground by Perkin-Elmer.

the gondola by a magnetic clutch. The ring acts as a brake on gondola motion and can be engaged on command.

The G. T. Schjeldahl Co., Northfield, Minn., which is developing the balloon system, is contemplating a two-balloon launch—one balloon on top of the other. This technique will permit launchings in winds up to 15 knots, in contrast with the usual requirement for a balloon launch of practically no wind.

The topmost balloon, smaller of the two, will be filled with helium for the launch. The lower balloon will be enshrouded in a three-foot tube of Mylar, substantially cutting down the flat plate area. At launch, the tube will rip open, freeing the lower balloon as the aerostat rises. As altitude is reached, the helium will expand into the lower balloon, with most of the gas transfer occurring between 10,000 and 14,000 feet.

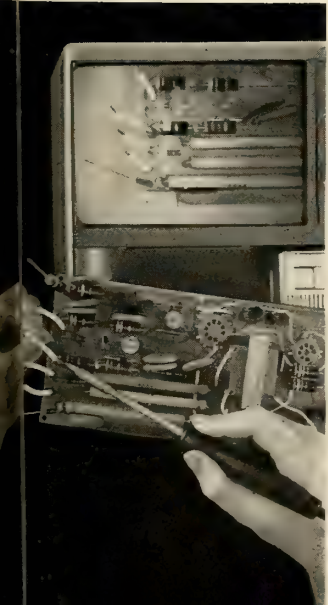
The balloon will be made of Mylar plastic reinforced with a dacron mesh. Developed by Schjeldahl for ONR, this material is reported to be lighter and stronger than polyethylene.

While the telescope is at altitude, it will be focused and monitored by a remote-control television system and a 70-station command channel developed by RCA Laboratories in Princeton. This TV system, using RCA's new high-resolution image orthicon tube, will be further developed for the *OAO*.

The Sierra Research Corp., Buffalo, is providing the telemetry.

To avoid damaging the telescope by ground impact, Vitro is considering use of a helicopter to snag the descending balloon system. The first test of such a system is tentatively scheduled for late fall provided an *H-21* type helicopter is available.

For the first flight, the balloon is to remain aloft throughout the night while observations are being made. There is no planned end to the number of subsequent flights. Schwarzschild enthusiastically told M/R: "Once that instrument works the way we hope it will, it's such a magnificent tool—we are certainly going to exploit it!"





# Fresh Successes Buoy Zeus Backers

**Army cites tests at PMR, White Sands and Ascension and reports new capability; AF cooperation is praised**

by James Trainor

ALTHOUGH still bogged down in politics, *Nike-Zeus* is achieving its development goals on or ahead of schedule, according to Army officials.

The enthusiasm and optimism of the *Zeus* development team—clearly evident in *MISSILE AND ROCKETS*' special *Zeus* report (M/R, Jan. 30, p. 26)—has been further enhanced by successful achievement of several major test objectives. These include complete systems tests at White Sands Missile Range, a partially successful firing of the complete missile at the Pacific Missile Range and the acquisition and tracking of ICBM warheads from Ascension Island in the Atlantic.

• **Target track radar works**—On May 27, the *Zeus* TTR at Ascension successfully tracked an *Atlas* ICBM warhead fired from Cape Canaveral. This test, in addition to proving ability of the radar to "lock-on" a target nose cone, provided valuable information to both the Army and the Air Force on the signature characteristics of re-entry bodies.

This data, plus information gathered from DAMP (Downrange Anti-Missile Program), has been used by the Army to test *Zeus* against simulated ICBM's. Tapes from these signature studies have been fed into the Target Intercept Computer (TIC), thus "fooling" both the TIC and the missile into seeing the re-entry body. The reaction of both systems to the simulated threat has been highly satisfactory, according to the Army.

• **Progress at White Sands**—An additional radar site is under construction at White Sands Missile Range. The Army is now checking out the acquisition radar for this second system.

In July, the Canard configuration of *Zeus*—or as the Army prefers to call it, the Forward Fin Control version—was fired from a "tactical" launch pit

with live first and second stages. This firing proved out the operational launch procedures as well as missile configuration.

The Army also has conducted tests on the optimum launch cell for *Zeus*. The missile has been launched from its underground cell, first with the cell vents open to dispel the blast and exhaust gases, then with the cell completely blocked. The test results proved the worth of the vented cell.

The TIC at White Sands is in place and is being used in test firings—together with other *Zeus* ground support equipment—to control the missile. The Army has also tested a new second stage for the missile which provides a substantial improvement in performance over the old propellant. The new stage is produced by Thiokol's Redstone Division.

• **Pt. Mugu firing program**—On Sept. 9, the first full-scale test of the *Zeus* system was conducted at Pt. Mugu. However, after approximately 20 seconds of flight, the three-stage missile exploded. The failure is attributed to a range safety device which will not be on tactical missiles or missiles launched from Kwajalein.

The test program at PMR has been kept purposely spartan, with only two firing pits and a battery control center. This is in keeping with the Army's philosophy of using the Pacific test site only for those high-altitude, long-range tests that cannot, due to range limitations, be conducted at White Sands.

The latter location, they explain, will be the major R&D test site. Difficulties encountered at PMR and Kwajalein will be corrected and tested at WSMR, because of the tremendous resources in men and facilities already invested in the desert test site.

• **Kwajalein work proceeds**—The brick and mortar construction at the Kwajalein test site is approximately 70% completed, and much of the mechanical checkout of the facilities has been finished. However, work is still being done on the electrical checkout. This work, the Army stresses, is either on schedule or ahead of schedule and should be completed prior to the critical firings against operational ICBM's slated for next year.

In connection with these firings, the Army points out that considerable progress has been made in the field of warhead discrimination. The TIC, the note, is the critical element, since it is responsible for data processing to pick out the target. An improvement in this area improves the discrimination capability of *Zeus*.

• **AF cooperation cited**—One of the chief concerns of people responsible for the *Zeus* development program is the tendency of the press, in particular, to build up the coming Kwajalein test as a contest between the Air Force and the Army. Nothing could be further from the truth, they say.

The cooperation that the Army has had from the Air Force, they stress, is every opportunity, has been outstanding and could not be more gratifying.

• **Non-technical developments**—Even though the ability of *Zeus* to intercept and "kill" enemy ICBM's is still being questioned, the Army's Director of Special Weapons, OCRD, Brig. Gen. David C. Lewis, confirmed a still greater extension of *Zeus* capability.

Speaking before a conference sponsored by the National Rocket Club in March, the general reported that minor changes in the system could extend the range of *Zeus* to 200 miles; major changes would yield 1200 miles in vertical range. This would make the system capable of destroying low-orbiting earth satellites as well as missiles.

The Kennedy Administration has continued the policy of withholding production engineering funds from the *Zeus* program. Not even the buildup in military capability, the resumption of nuclear tests and the Berlin crisis have altered this decision. Nor do Army officials expect that the White House will reverse itself. However, they do point out that the pre-production funds have not been officially linked to the success of the Kwajalein tests; therefore a decision could be made at any time.

In any case, nothing has dimmed the faith of the Army in the ability of *Nike-Zeus* to provide an effective antimissile defense. With the program achieving the technical milestones set for it, Army confidence is high that *Zeus* will eventually prove itself—to everyone's satisfaction.

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# NASA Opens Drive to Recruit 4000

THE BIG BUILDUP is beginning at NASA.

The space agency starts a recruiting campaign this month to add some 4000 employees by June 30 of next year. These will include 2000 scientists and engineers for the *Apollo* and scientific satellite programs.

Approval of a supplementary appropriation bill in the last moments before the Congressional session ended cleared the way for NASA to transfer \$10 million from its research and development budget to salaries for new employees.

The agency has already authorized recruitment of some 3000 employees under funding included in NASA's Fiscal '62 budget. Permission to switch the \$10 million gives back to the agency about half of a \$20-million cut in salaries and expenses slashed from the budget earlier by Congress.

NASA originally asked Congress for authority to hire 4900 new personnel in Fiscal '62. The new funds mean the space agency has money for about 4400 of these, with approximately 400 jobs already promised to applicants.

If all the new jobs are filled, NASA's total employment will rise to 24,400. Approximately 700 of the new jobs will be at NASA headquarters in Washington.

As the recruiting drive gets under way, NASA recruiting offices will be set up in New York, Los Angeles and Dallas. A major effort to attract new employees also will be made at next week's meeting of the American Rocket Society in New York.

At the same time, advertisements will be run in leading newspapers and trade magazines. Other NASA recruiters will visit cities across the country and scout technical and professional meetings and leading educational institutions.

Approximately 45% of the new positions will require scientific or engineering backgrounds. With a turnover rate of some 7% this means that about 200 such jobs are open. Remainder of the new positions are administrative, support and trade personnel.

NASA Personnel Director Robert J. Likken expects no difficulty in filling these jobs.

This will not be true, he asserts, in the engineering and scientific area, where NASA is faced with two major problems:

## NASA Estimate of Government & Industry Salaries for Engineers & Scientists

| Civil Service Salary Grade | Government Rate | Industry Rate |
|----------------------------|-----------------|---------------|
| 5                          | 5,335           | 6,350         |
| 7                          | 6,345           | 7,400         |
| 9                          | 6,435           | 8,500         |
| 11                         | 7,560           | 9,800         |
| 12                         | 8,955           | 11,600        |
| 13                         | 10,635          | 14,200        |
| 14                         | 12,210          | 15,600        |
| 15                         | 13,730          | 18,500        |
| 16                         | 15,255          | 23,000        |
| 17                         | 16,530          | 35,000        |
| 18                         | 18,500          | 38,000        |

(1) The inability to compete with the top salaries offered by industry.

(2) Lack of opportunity to tap the 1962 graduating classes at technical educational institutions until sometime in Fiscal 1963.

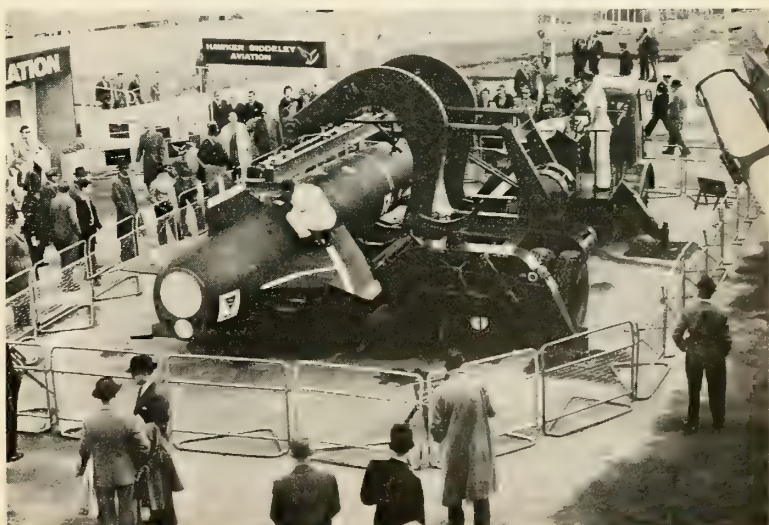
While government salaries compare favorably in the beginning Civil Service grades, the spread widens until top government personnel are making less than half what industry is paying for comparable jobs (see chart).

• **Possible improvement**—One partial solution to the problem may be forthcoming in the near future. NASA and other government agencies have asked the Civil Service Commission to approve a policy change which would enable them to pay all scientific and engineering employees at the top rate permitted by the various Civil Service grades. Thus, such employees would not have to work through perhaps three small pay raises within the GS-9 pay scale. Instead, when considered ready for promotion, they would immediately jump to the pay scale in the next grade.

Space agency officials also are counting on patriotism to help overcome the salary gap. They feel many Americans will forego the high salaries offered by industry for a chance to play a part in the U.S. space effort.

NASA officials point out that almost anyone with a degree in a physical science or engineering can expect to be qualified for some job at NASA.

For instance, among major areas included in the 2000 new positions are fluid and flight mechanics, materials and structures, data systems, propulsion and power, flight systems, instrumentation systems, measurement, experimental facilities, space sciences, life sciences, and project management. ■



## Off-Loading Blue Steel

METHOD OF TRANSFERRING A. V. Roe & Co. Ltd.'s Blue Steel air-to-surface missile from transporter vehicle to aircraft loading trolley was shown at Farnborough Show. The V-bomber nuclear stand-off weapon system is the only one in U.K. arsenal.



## electronics

# Litton Tape Recorder Survives Impacts

***Sandia tests using unusual air gun indicate unit made by Westrex Div. can live through flights on warheads***

**by Charles D. LaFond**

BEVERLY HILLS, CALIF.—A new miniature tape recorder, used to collect data during flight tests of experimental missile warheads, has survived impacts up to 1500-g without losing previously recorded data.

Tests recently completed by Sandia Corp. at Livermore, Calif., using a high-velocity air gun, also have shown the recorders capable of continued data recording while undergoing 750-g shocks sustained for 5 milliseconds.

Developed here by Westrex Recording Equipment Division of Litton Systems, Inc., the 5-lb. cylindrical units were built to withstand all the conditions experienced by missile warheads. These, designers say, include all the high-g loadings encountered in high-velocity water impacts, ground impacts and launch accelerations.

To assist in its studies, Sandia scientists have been searching for a recoverable recorder with just these

characteristics so that design evaluation of weapon systems during flight can be made. Results of its recent tests indicate that the Westrex recorder has met all performance requirements.

Sandia, a prime contractor to the Atomic Energy Commission, is currently engaged in R&D of ordnance phases of the nuclear weapons program.

• **Air gun cuts costs**—The 8-inch air gun developed by Sandia is one of the few test devices of its kind in existence today. Capable of reproducing launch and impact g-environments under many laboratory conditions, its use permits evaluation tests which otherwise could only be obtained through time-consuming, costly missile flights.

During the tests, Sandia engineers installed the tiny tape units in a special four-recorder jig. The jig formed a part of an aluminum honeycomb "target" against which the air gun was aimed to produce controlled, sustained high-g loads.

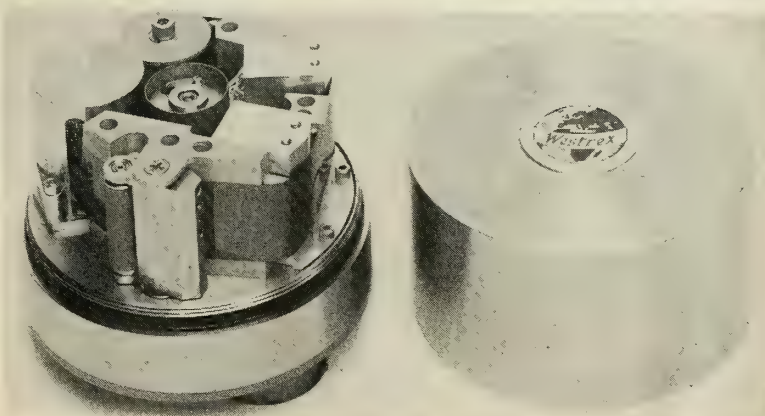
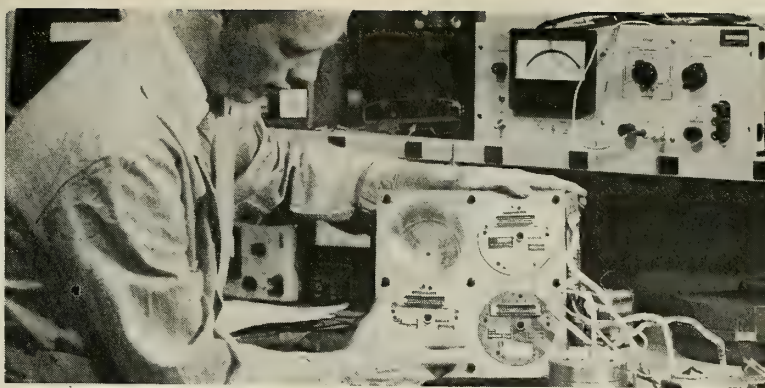
missiles and rockets, October 2, 196



→  
**RECORDERS ARE MOUNTED** in special jig for air-gun warhead-impact testing. These units, under simulated flight conditions, survived 1500-g shocks without loss of recorded data during recent tests at Sandia's Livermore Laboratory.

←  
**EIGHT-INCH** air gun, one of few test devices of its kind in existence, is used by Sandia Corp. to simulate high-g loads present during a missile flight. New missile-borne tape recorders, developed by Westrex, are mounted in the aluminum honeycomb "target." Information has been recorded through impact shocks of 750-g, sustained for 5 milliseconds.

→  
**MINIATURE 5-LB.** recorder carries 100-ft. reel of 1-in., 1-mil thick, Mylar tape providing 14 data tracks. Transport speed is 15 in. per second.



## 1500 g and Retains Recorded Data

During the tests, information was recorded through impact shocks of up to 750-g, sustained for 5 msec. No damage was experienced by the recorders, says Sandia. In subsequent tests, the devices survived 1500-g shocks for 3 sec. without loss of recorded data.

• **Recorder details**—Westrex' recorder, designated type RA-1653, actually was designed to operate through a 100-g 11-millisecond square-wave shock and survive a 1500-g impact.

Hermetically sealed, its can-shaped case measures 3-in. x 4-in. dia. It carries approximately a 500-in. long reel of 1-in. wide, 1-mil base Milar magnetic tape.

The present system is designed for 10-volt dc operation (at 25 watts) with transport speed of 15 ips.

The 1-in. tape allows 14 in-line recorded or record/reproduce channels. A staggered array of two 7-track recording heads can be used, says Westrex, if

cross-talk requirements demand their need. Recording speed also may be altered if necessary.

Cross-talk is better than 50 db below signal level for staggered 7-track leads and 40 db for a single in-line 14 track head.

Gap-scatter, designers say, is a maximum of  $\pm 50$  microinches per head.

Choice of recording conditions or method is determined by the required frequency response and other performance requirements.

For carrier-erase recording (using a 1500 cps carrier) a frequency response up to 2 kc is available; for direct recording, response range is from 100 cps—100 kc.

In the transport mechanism, head-to-tape contact is maintained by a tape support and tension control over the full tape path. The design, according to Westrex, also minimizes wow and flutter measurements to within 1 percent

rms since tape-path resonance is considerably reduced. In the range of 6-250 cps, flutter is approximately 0.7 percent maximum.

Recorder starting time is 20 msec.

Design operating range of the data recorders is from at least  $-65^{\circ}$  to  $165^{\circ}$ F. Below 3 kc, says Westrex, there is no significant vibration effect on recorder performance. Natural resonance frequency of the unit is 5 kc.

In addition to the already related test results obtained by Sandia, Westrex engineers say they have tested and operated the units successfully at loads up to 1250-g with a 5-msec. square-wave shock.

With the use of head pressure pads, the company believes the recorders will be suitable for recording applications through shock levels well above those already attempted.

Toward this end, R&D will be continued by the company. ■





## ACTION!

Major advances, coming in increasingly rapid succession, are the leaders of the solid rocket propulsion industry, dramatic evidence of the quickening pace of this nation's big booster effort.



The next major achievement will be the firing soon of an operational prototype solid rocket of approximately one-million-pounds thrust at UTC's Development Center.

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# Test Lab Exploits Automation

AUTOMATION of mechanical tests in environmental testing is giving laboratories a new set of tools with which to handle the fast-growing complexity of satellite and missile components.

At the Wayne, N.J., headquarters of Associated Testing Laboratories, Inc., a large test batch of batteries used in satellites and other satellites to send telemetered information to tracking stations has recently put through the automated procedure.

The limits of the tests were programmed into the testing equipment by means of a punched tape, capable of doing the equivalent of 100 days of testing. On command, the equipment selects a component for testing and runs it through the procedure—in the case of the batteries, putting preset over drains on them at preset intervals.

Afterward, the testing equipment evaluates the component's performance in terms of the test limits. Part of the equipment includes an electric typewriter, which prints the performance record—along with the time of day, the component's code number, and its passing or failure. A continuous strip-chart recorder is also connected from time to time.

The equipment can make such decisions as whether or not to stop the test if the battery does not meet specifications. The shut-off is announced by ringing on the tape or data sheet or by sounding a buzzer.

The human element enters the picture of the test only when a technician or engineer inserts a data sheet or tape, checks portions at the beginning of each test, and removes it afterward. The record can be bound directly into

the report of the test, or filed away for reference.

Analysis of the results puts the procedure again into the hands of the machine. There is, however, a gap still subject to human error: the transcription and feeding of the results into the computers.

At Associated this will be bridged, according to present proposals, by substituting punched cards for the data tapes and sheets. The cards can then be fed directly into the computers.

• **Advantages**—The benefits of automated testing are numerous. It eliminates human error both in the testing itself and in the observation and recording of test results. In terms of rapidity in testing, it can out-perform a human technician; battery test readings can be made at 50 per minute or more.

Moreover, a large number of batteries, or similar classes of components, can be life-tested simultaneously, without using additional equipment. The equipment can be programmed to switch from one battery to another in a fast pattern to make a continuous periodic sample.

Furthermore the equipment can simultaneously record the effect on components of a number of simulated environmental factors.

Companies supplying components for the testing systems of Associated Testing Laboratories, Inc. include: International Business Machine Corp. and Friden, Inc., automatic typewriters; Cubic Corp., digital voltmeters and ohmmeters, and scanner systems; Hewlett-Packard Co., printers, digital clocks; Kin Tel Div., Cohu Electronics, Inc., scanner systems; and Non-Linear Systems, Inc., digital voltmeters. ❖



## Is there a challenge for you at UTC?

In addition to its big booster development activity, UTC is carrying forward major programs in hybrid rocket engines... high energy storable liquid propellant engines... and high-performance solid engines for upper stage applications.

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**SR. DESIGN ENGINEER**—Supervision of a group in design of solid rocket motor components. Requires professional degree and a minimum of 5 years rocket design experience.

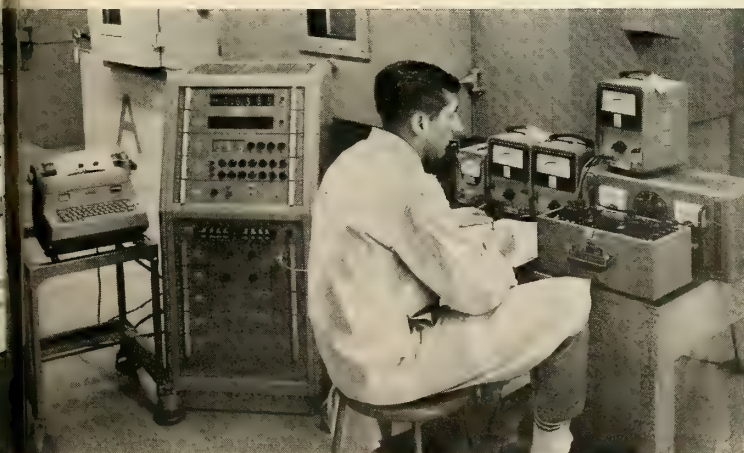
**ENGINEERING ANALYST**—Systems Design. To formulate mathematical models of systems engineering problems and implement solutions by analytical techniques. Requires degree with solid mathematical foundation and 2 years design or systems experience.

**PROCESS ENGINEER**—For rocket motor processing studies and process methods improvements. Requires chemical engineering degree and direct propellant processing experience.

**PROPULSION ENGINEER**—For analytical studies of solid and liquid propulsion systems. Requires degree with extensive mathematics, thermodynamics and fluid mechanics background.

*All qualified applicants considered without regard to race, creed, color or national origin.*

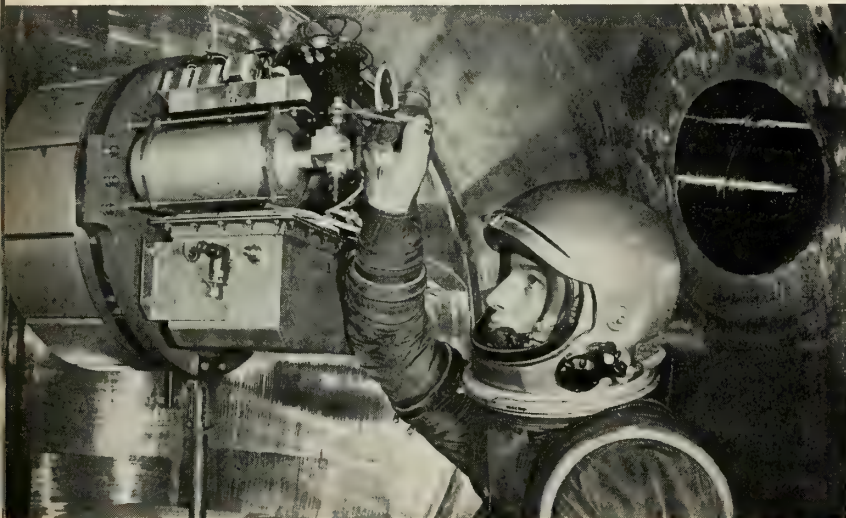
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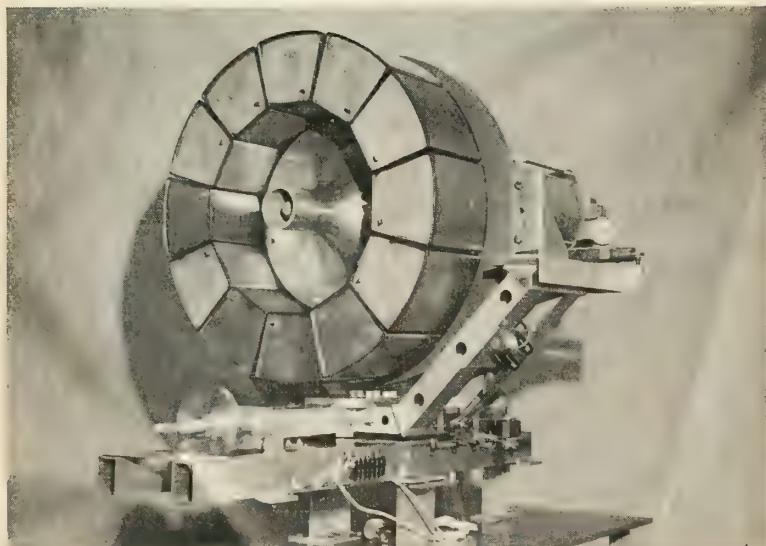
**OMATIC EQUIPMENT** at ATL is monitored by technician as it tests Polaroid part.

# Republic Plasma Pinch Engine to Fly

**Company says lightweight XE-1A will operate in space indefinitely and has bigger thrust potential than R&D rivals**



*IN ENVIRONMENTAL CHAMBER, technician adjusts XE-1A plasma pinch engine described as "first operating self-contained electrical propulsion package."*



*PREDECESSOR OF XE-1A—the XE-1—mounted on stand designed for accurate measurements of wide range of thrusts. Note XE-1's 12-element capacitor bank.*

REPUBLIC AVIATION CORP. reports its plasma pinch engine will be ready for flight evaluation in space early next year. Powered by batteries and solar cells, the engine is said to be capable of indefinite operation in space environment.

This was disclosed last week when Republic unveiled its XE-1A electrical space engine.

The lightweight engine—which gets its thrust by magnetic pinching of an inert gas such as nitrogen—was described by company scientist Alfred E. Kunen as "the only electrical engine in existence capable of operating today, just as it will in actual use on spacecraft, ships and satellites."

Kunen says that the XE-1A has already been tested satisfactorily at the Propulsion Laboratory of the Aeronautical Systems Div. at Wright Field. He affirms that "During these tests, direct thrust measurements were taken which indicate a greater thrust potential than that of any other electrical space propulsion system under development."

Republic declined to say whether there were any commitments to put the engine in a satellite next year. But company spokesmen noted that a plasma engine such as the XE-1A has important space missions. Kunen called it the ideal acceleration system for:

- Maintaining spin rates in satellites that are spin-stabilized.
- Changing a satellite's orbital path.
- Maintaining a satellite in a low altitude orbit by offsetting the effects of atmospheric drag.
- Maintaining a satellite in a 24 hour orbit to perform delicate functions such as rendezvous or docking with larger space stations.
- Preserving the relative position of a host of satellites performing a single mission.

The present engine weighs 150 lbs. and is about 20 in. long and 24 in. in diameter including the capacitor bank.

• **How it works**—In principle, the

missiles and rockets, October 2, 1960



# Early '62

pinch engine consists of a nonconducting cylinder filled with gas and with disc electrodes at each end. When a potential is applied between these electrodes, a discharge in the form of a current sheath travels through the gas adjacent to the inside walls of the cylinder.

The magnetic field created by the flow of the current forces the current sheath radially inward, compressing and pinching the fluid within the cylinder. If there is a hole or nozzle at the end of the cylinder, this pinching effect expels the gas, thereby producing a propulsive force. If the fluid within the cylinder is combustible, the pinch will detonate the fluid, thus adding chemical energy to the expellant.

Specific details of the XE-1A were not given, but it is known to be similar to its predecessor, the XE-1.

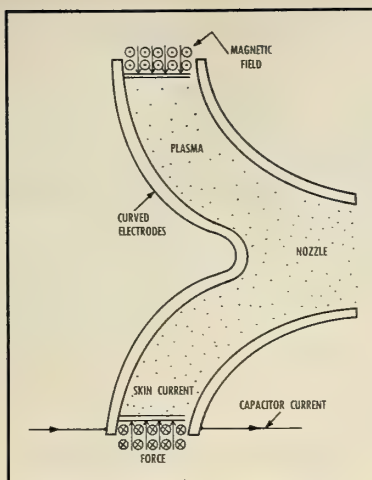
The XE-1 engine includes all the components needed for self-sufficient operations except the power supply. It consists of radially-dominant-electrode nozzles (the disc electrodes shaped to form nozzles), and an electrical system with 12 capacitors rated at 3000 volts, 10 microfarads each. The thrust of the XE-1 is of the order of 0.01 lbs. The range of specific impulse is between 100 and 7000 seconds.

The follow-on engine in Republic's development program, the XE-1A, went to Wright Field this March for testing. It is a completely self-contained engine, including its own integral battery power supply delivering 1-kw of energy.

Thrust and impulse levels of the XE-1A are said to be similar to the XE-1.

The Air Force Office of Scientific Research—one of the backers of Republic's plasma work—cites the engine as an instance where hardware development arose directly out of basic research studies. OSR observes that "though many fundamental problems remain before electro-gas-discharge phenomena are fully understood, the satis-

files and rockets, October 2, 1961



CROSS-SECTION of curved electrodes during pinch exerted by magnetic field.

factory use of the phenomena as a propulsion concept appears clearly indicated."

• **Advantages cited**—Compared with other forms of electrical propulsion, the plasma pinch engine is said to hold the following advantages:

—Large thrust for specific impulse required.

—Broad range of exhaust velocity (specific impulse) in the required range for most missions.

## First Ion Engine Showing

*THE FIRST experimental ion engine ever publicly shown in operation was revealed by Hughes Aircraft Co. last week. Developed under a National Aeronautics and Space Administration contract, the engine develops less than 0.1-pound of thrust. Plans call for space-testing an advanced version by late 1962.*

*Here is how the engine works:*

*Cesium, an easily ionized element, is stored in a reservoir out of which the element's vapor is diffused. The vapor then passes through a hot tungsten element where the cesium is ionized. Next, a system of electrodes apply a voltage to the ions in order to accelerate them to high exhaust velocity. Finally, the high-velocity ion beam runs through a region where electrons are injected to neutralize the positive cesium ions.*

*Through beam neutralizing, an effective thrust can be generated because there is no relative charge between the space vehicle and its expellant.*

- Stop/start capability.
- Variable specific impulse during operation.
- Variable thrust performance during operation.
- Simplicity.
- Inherent reliability.

In proposing varied uses of their engine, Republic engineers say that the plasma engine will provide an effective propulsion system which can be coupled with guidance instruments to correct errors in satellite orbits. For example, they say, satellites could be placed in an orbit so precise that their position could easily be predicted with accuracy years in advance. "And should the need arise, a satellite could be transferred from one orbit to another, thus obviating the need for additional launchings."

The plasma engine, because of its light weight, could also be installed in a satellite to prevent tumbling, a tendency that interferes with the ability to send and receive messages and to take pictures.

• **In the beginning**—Republic's Plasma Propulsion Laboratory was organized in 1957 to conduct research in plasma physics. It was initially funded by the company; subsequently, contracts came in from the Air Force Office of Scientific Research, the Office of Naval Research, and the Aeronautical Systems Div., Wright Field. The Wright Field contract called for developing a laboratory operational model of a pinch-pulsed plasma engine. This contract led the way from the research engine to today's XE-1A.

Here is the way the work progressed:

1958—At a seminar meeting at Stanford University, Kunen showed the feasibility of developing a propulsion system using the pinch-pulse effect to accelerate plasma in an electrical propulsion system. By August, Kunen and his staff at Republic had built a working laboratory breadboard model of a plasma pinch engine.

1959—Proof of the principle for this engine was successfully demonstrated. A laboratory model was built.

1960—Engine Model XE-1 was assembled, built and tested. Preliminary tests showed average thrust values near 0.01 lbs.

1961—XE-1 was demonstrated at Wright Field laboratories early in the year.

March, 1961—Model XE-1A was assembled, built and shipped to Wright Field for testing. It was successfully demonstrated in the Electrical Propulsion Laboratory environmental chamber.

September, 1961 — XE-1A engine revealed to the public. ❧

# Many Missile/Space Issues Deferred

**Next Congress will try to shape legislation on indemnification, renegotiation, patents, other matters**

by Charles Schaeffer

CONGRESS, adjourning last week after the longest first session in 10 years, left behind a number of unresolved issues affecting the missile/space industry.

Since the session beginning next January is a continuation of the 87th Congress, all unfinished bills and work carry over. Here's the situation on the major bills still pending:

- **NASA Indemnification**—A carryover from the previous Administration, the proposal is to give the space agency authority to indemnify contractors against "unusually hazardous" risks. Senators were ready to accept the legislation after inducing NASA to limit government liability to \$500,000,000 for any one disaster, provided the contractor has maximum commercial insurance available.

Members of the House Space Committee quarreled with the idea of imposing federal tort limitations on the separate states; they pushed a bill minus the limitation through the House. This was pigeonholed by Senators and remains to be resolved next year, if at all.

- **Patents**—Opposing factions, one favoring tighter, the other more liberal, government patent provisions continued throughout the session to war openly and behind the scenes. Complicating the issue, NASA did an about-face and said it could get along this year without a liberalization giving it more power to waive claim to the titles of inventions developed under space agency contracts. There were assurances that the Administration was developing an overall policy on government patents, but as Congress adjourned those close to the subject on Capitol Hill could perceive no hint of its imminence.

Meanwhile, Sen. Russell Long (D-La.), head of a Senate monopoly subcommittee, remained in favor of a bill to create a new federal agency to preserve the rights of the government to all inventions developed with federal funds. Rep. Emilio Q. Daddario (D-Conn.) continued to develop a record

for action on NASA's patent policy next year.

- **Renegotiation**—An important industry issue facing the next session is whether to modify the Renegotiation Act. The Board recently revised its procedural rules in anticipation of a new attempt to soften the act. These paper reforms probably will help the Board's argument against modification of the law itself.

To some congressional critics, however, the new rules represent no substantial concessions. The Joint Committee on Internal Revenue and Taxation has completed a report documenting complaints against the administration of the Renegotiation Act, but its final recommendations—due in January—are still in the fluid stage. Opposition to modification on the part of the influential chairman of the House Armed Services Committee, Rep. Carl Vinson (D-Ga.), remains undiminished.

- **Negotiated Procurement**—A bill by Sen. John Sparkman (D-Ala.), to give the General Accounting Office authority to review in advance negotiated procurements, went nowhere. But the Department of Defense reported to Congress it was revising its procurement rules in line with recommendations by the House and Senate Armed Services Committees. One of these would authorize a procurement officer to reduce target costs where he can reasonably show the price was based on inaccurate or out-of-date cost data.

The essence of Congressional objections to the Pentagon's heavy reliance on negotiated procurement was to be distilled in the regulation changes. Although Senators were mostly inclined to accept DOD assurances, Chairman F. Edward Hébert (D-La.) of the House Armed Services Investigations Subcommittee said the policy of advertised bidding should be enacted into law. His proposed bill still is pending.

A lengthy probe of sole-source negotiated procurement disclosed laxness; investigators have joined GAO in de-

manding that safeguards be written into the rules permitting sole-source buying.

- **Identical bids**—The House-passed bill requiring contractors to file affidavits that they did not collude in the bids still was pigeonholed in the Senate.

- **Missile strikes**—Sen. John McClellan (D-Ark.), disenchanted with violations of labor's no-strike pledge to the Administration, proposed legislation to outlaw work stoppages at defense sites. Introduced in the waning days of the session, it was not considered.

- **Local taxes**—A bill by Rep. A. J. Herlong (D-Fla.) to make defense and other government contractors liable for state and local taxes was not enacted but can be brought up again.

- **Space Communications**—Hearings before the Senate Small Business Monopoly Subcommittee on a space communications system, set for Oct. 17, have been postponed until November. A committee of 10 international common carriers is to submit its recommendations to the FCC before Oct. 13; the 15 days following that are set aside for submission of views by interested parties.

Half a dozen committees and subcommittees jumped on the FCC proposal to let American Telephone & Telegraph head a development study.

- **NASA vehicles**—Chairman Robert S. Kerr (D-Okla.) of the Senate Space Committee indefinitely postponed public hearings set for last week on NASA's *Saturn* and *Centaur* vehicle programs. He said a new date for the hearings would be announced later.

- **Central Procurement**—Action is pending on a GAO recommendation to Congress that DOD set up a central procurement agency to handle all common supply items, including certain weapons and spare parts.

Earlier, Defense Secretary Robert S. McNamara announced establishment of a single Defense Supply Agency. Its procurement activities are limited, but they may later take in missile spare parts and electronic equipment.

missiles and rockets, October 2, 1968



## A.T.&T. Chief Denies Plans to Control Communications

"WE HAVE ALREADY made certain that we have no intention of getting into the space hardware business, even if that were possible."

That statement was made by American Telephone and Telegraph board chairman Frederick T. Kappel in Boston last week in answer to charges that A.T.&T. plans to monopolize the space communications business.

Space hardware, he added, is the business of missile/space industry firms and most of the money required for a satellite communication system will be paid to them for their products and services.

"We are only concerned to make sure that what we spend our money for will provide high-quality, reliable service," Kappel said.

He denounced as "sheer imagination" the suggestion that A.T.&T. is out to dominate and control space communications.

"This must be a world-wide system of the greatest use, and the rest of the world will likely own more of it than is owned in the United States," the board chairman stated.

He said that A.T.&T. proposals are completely consistent with President Kennedy's policy statement of last July favoring private ownership under regulation. Kappel pointed out that the statement established stringent conditions for equitable sharing of the satellite system and effective competition in the manufacture and supply of its equipment.

"The Federal Communications Commission has full regulatory authority to enforce these conditions and has made perfectly clear that it intends to do so," Kappel said.

His remarks came as President Kennedy, speaking at the United Nations, renewed his proposal for a "global system of communications satellites linking the whole world in telegraph, telephone, radio and television."

Kappel pointed out that A.T.&T. signed a contract last July with NASA under which the company will provide satellites and NASA the rockets for experimental launchings next year.

"In building the ground station at Rumbold, Maine, that will be used in testing the experimental satellites," he said, "we have already enlisted the help of 97 contractors and subcontractors. When this station goes to work next spring, it will contain certain basic electronic gear, such as the ruby maser, provided by Bell Laboratories which developed and designed it. The greater part of the entire installation, however, is being supplied by others, although built to our specifications and under our supervision."

Kappel said proposals envisioning government ownership of satellite communication systems are "short-sighted" and a departure from American tradition.

• **On '56 settlement**—He noted that Rep. Emanuel Celler (D-N.Y.) and Rep. James Roosevelt (D-Calif.) had raised the question of violation of anti-trust laws by A.T.&T., including the assertion that the firm had negotiated a consent settlement with the Department of Justice in 1956 rather than

defend itself against charges of wrongdoing.

In reply, Kappel said: "I fully shared the confidence of our lawyers that if the suit were brought to trial, we and not the Department of Justice, would win it. But we weighed the cost. We weighed the energy that would have to be expended. We knew the need to concentrate attention on the tremendous service job we had to do. We concluded that in order to put ourselves back to work and get on with our job, we would recommend acceptance of the very considerable restrictions that the Justice Department insisted on imposing as part of a consent decree." ■

## Bill Aimed at Giving More Contracts to Small Firms

REGULATIONS to steer more contracts and subcontracts to small business will be drafted by the Defense Department and General Services Administration under a bill passed by Congress.

The bill (HR 8762) gives DOD and GSA chief authority to set up new measures, but requires that the Small Business Administration concur in them. If the SBA rejected a proposed regulation, the final decision would be up to the White House.

One section of the bill is aimed at having DOD, GSA and SBA cooperatively develop a small business subcontracting program. It is designed to insure that small concerns are considered fairly as subcontractors and suppliers in prime contract awards over \$1 million and on subcontracts of \$500,000.

Prime and subcontract award holders could be asked—through the procurement agencies—to consult with SBA officials about subcontracting opportunities.

Meanwhile, The Martin Co. says it expects to raise its purchases from small business this year by about 28% over last year, and General Electric says it spent 21% of all its defense dollars with small business during the first half of 1961.

Martin spent \$106,393,000 with small concerns in Fiscal 1961 and \$88,864,000 in Fiscal 1960. The company says about 32% of the total spent in the first half of this year went to small business.

GE says 40,000 firms shared in the company's major defense projects during the first six months of this year, and small firms received almost half of its \$1.5 billion expenditure on defense and non-defense procurement. ■

## Financial Reports

| COMPANY                           | PERIOD        | INCOME       |              | EARNINGS   |            |
|-----------------------------------|---------------|--------------|--------------|------------|------------|
|                                   |               | 1961         | 1960         | 1961       | 1960       |
| Max Electronics, Inc.             | 6 Mo. June 30 | \$ 2,390,107 | \$ 2,029,902 | \$ 26,004  | \$ —       |
| American Marietta                 | 9 Mo. Aug. 31 | 268,483,257  | 268,069,005  | 15,462,450 | 17,202,260 |
| Av Corp.                          | 9 Mo. Aug. 31 | 233,558,320  | 240,016,634  | 8,797,648  | 7,318,365  |
| Cons Radio Co.                    | Year, July 31 | 215,000,000  | 190,566,387  | 3,075,000  | 6,532,669  |
| International Rectifier Corp.     | Year, June 30 | 14,512,000   | 13,124,586   | 1,080,000  | 1,206,000  |
| New Hampshire Ball Bearings, Inc. | Year, June 30 | 8,314,834    | 7,140,177    | 689,226    | 588,944    |
| RCA Electronics, Inc.             | Year, Apr. 30 | 1,847,016    | 1,090,396    | 64,541     | 62,004     |
| Ryan Aeronautical                 | 9 Mo. July 31 | 67,848,487   | 86,073,812   | 2,176,159  | 1,772,647  |
| Weinghouse Electric Corp.         | 6 Mo. June 30 | 920,381,000  | 953,844,000  | 19,561,000 | 40,454,000 |

by Dr. Albert Parry

## Soviet-manned rockets in East Germany

are not the only such weapons in that country. In addition to a fairly sizable number of these, missiles have been issued by the Russians to East German troops under East German command.

This information was given to me by a high source in the United States headquarters in West Berlin during my recent visit to the beleaguered city. Soviet Russian units of the occupational forces apparently are in charge of long-range missiles while East German troops are in possession of medium-range and tactical missiles.

"But can the Soviets really trust their East German officers and soldiers with those precious rockets?" I asked my informant in West Berlin. "Would such Germans, in case of a showdown, indeed remain loyal to their Russian Communist bosses?" The source replied: "We must remember that before the Second World War there was a strong Communist Party in Germany. Neither Hitler nor time succeeded in destroying it completely. Many of its stalwarts either stayed in East Germany where the war's end found them or have moved there since the war from West Germany. Their sons are now the smug and dangerous elite ordering the populace around for Khrushchev and Ulbricht.

"These young men, and some who are not so young, are in the top positions of the East German governmental and Party apparatus. They are also commanders of the East German troops, including the new rocket units. They are the Kremlin's praetorian guard in East Germany, as yet completely loyal to Khrushchev. Yes, that Red German elite love their power and privileges and mean to keep them. Khrushchev can depend on these men, on their use of the weapons he has given them."

## In Vienna, at a conference of atomic scientists,

I congratulated one of the two Soviet physicists present on Gherman Titov's orbiting achievement. His smile broadened as I added that I had expected the Soviets to follow up Yuri Gagarin's exploit by sending a woman, not another man, into orbit.

The Russian scientist shook his head: "I doubt if women, even our sturdy Russian women, would be sent into outer space in the near future. Women, no matter how strong, just cannot stand the difficult tests we give to our would-be cosmonauts. No matter how tough or husky they appear to be, they just wouldn't do. True, some Russian women may have been among our many volunteers. But if so, they didn't pass. Even the vast majority of men volunteers can't pass.

"You know, a tremendous number of Russian men volunteered in 1957-60, and a perfectly enormous process of weeding-out took place before Gagarin, Titov, and a few others were chosen. No woman can endure the superhuman tests they passed. You would be amazed to learn what wonderfully strong men have failed those tests."

## A Russian-American traveling in Italy

this summer met two Soviet engineers who grew quite frank with him as, in their combined ignorance of Italian, they pooled their linguistic resources—first to buy trinkets, later to order food. The wine accompanying the spaghetti loosened the two Soviet tongues to a point where one of the Muscovite engineers suddenly asked the Russian New Yorker:

"Tell me honestly, candidly, was our *Sputnik* in October, 1957, actually the first artificial satellite to circle the earth? Weren't you Americans ahead of us with a *Sputnik* of your own, and most successfully?"

It took the Russian-American some minutes to realize that the questioner was not joking, and then it took some more time to convince the Soviet pair that their *Sputnik* was in fact first. The Russian engineer who had asked the question was delighted to hear the answer.

"Thank you, thank you so much," he exclaimed. "You see, we in Russia don't believe anything our government tells us. They lie to us all the time. It's a veritable plague. . . ."

TABLES OF BLACKBODY RADIATION FUNCTIONS, M. Pivovonsky and M. Nagel; The Macmillan Co. 481 pp., \$12.50.

Presented is a tabulation of Planck's radiation law and a number of related functions describing the radiant and luminous properties of ideal thermal radiators.

The tables cover a broad range of wavelengths and temperatures, saving the researcher time-consuming interpolations and other calculations. Conversion data have been included to prevent obsolescence in case of changes of the atomic constants on which the tables are based.

HANDBOOK OF ASTRONAUTICAL ENGINEERING, Heinz Herman Koelle, Editor. McGraw Hill 1814 pp., \$27.50.

This is the first summary of the present state of the art of space flight technology.

Prepared by a team of 150 specialists from government agencies, industry, and universities, the Handbook is the culmination of three year's work in screening books, articles and reports.

Some of the special topics covered include: space flight applications and implications, economy of space flight, program management and systems engineering, free-flight trajectories close to celestial bodies, space communication, advanced propulsion systems, and ground and space operations.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

MISSILES AND ROCKETS, published every Monday with the exception of the last Monday in December at Washington, D.C., for October 2, 1961.

1. The names and addresses of the publisher, editor, managing editor and business manager are: Publisher, Edward D. Muhlfeld, Washington, D.C.; Editor, William J. Coughlin, Washington, D.C.; Managing Editor, William E. Howard, Washington, D.C.; Business Manager, Leonard A. Eiserer, Washington, D.C.

2. The owner is: American Aviation Publications Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Stockholders owning 1% or more of total amount of stock: Wayne W. Parrish, Washington, D.C.; Leonard A. Eiserer, Washington, D.C.; Eric Bramley, Washington, D.C.; Jay Shuler, Springfield, N.Y.; Robert R. Parrish, Chicago, Ill.; E. J. Stackpole, Harrisburg, Pa.; Fred S. Hunter, Washington, D.C.; A. H. Stackpole, Harrisburg, Pa.

3. The known bondholders, mortgagees, and other security holders owning or holding 1% or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include in cases where the stockholders or security holders appear upon the books of the company as trustees or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed through the mails or otherwise to paid subscribers during the 12 months preceding the date shown above was: 31,631.

EDWARD D. MUHLFELD,  
(Signature of publisher)

Sworn to and subscribed before me this 18th day of September 1961.

RETTA B. LUDDEKE,  
Notary Public.

(My commission expires Nov. 14, 1962)



# names in the news



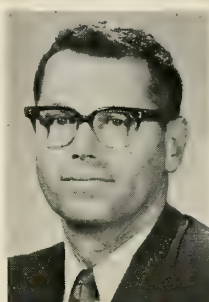
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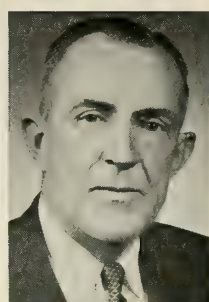
BACON



CHASE



BARNES



BARR

**Howard W. McFarland:** With Marquardt Corp., Van Nuys, Calif., for more than ten years, appointed manager of Space Propulsion Project Dept.

**Herbert A. May, Jr.:** Appointed assistant to **George M. Bunker**, Martin Co. chairman; **Roland (Bud) Carlson** named to replace May as assistant to Marquardt president **William B. Bergen**.

**William C. Ruch:** Named director of development research; **Dr. Robert W. May**, director of laboratory research; and **Charles D. Boyer, Jr.**, director of planning research, Allied Chemical's General Chemical Division, Research Laboratory, Morris Township, N.J.

**Capt. Noel R. Bacon, USN (ret.):** Joins American Machine & Foundry Co.'s Government Products Group as manager of program controls. Prior to joining AMF, Bacon was Commanding Officer of U.S. Naval Photographic Center.

**Patrick S. Chase:** Elected president, Electronic Instruments, Inc., Costa Mesa, Calif., succeeding the late **James A. DeLoach**, founder of the firm.

**Stanford B. Kaynor:** Promoted to secretary of U.S. Industries, Inc., New York City.

**J. E. Egan:** Formerly with Kaiser Electronics, Inc., appointed assistant to the president of Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif.

**Ray L. Ash:** Former executive vice president, elected president, Litton Industries, Inc., Beverly Hills, Calif., succeeding **Charles B. Thornton**, now chairman and chief executive officer.

**Frank C. Kerr:** Named marketing manager of newly formed Electro-Mechanism Division, Omega Precision, Inc., Azusa, Calif. Prior to joining Omega, Kerr was marketing manager for the former Missile Production Div., Beckman & Whitley, Inc.

**Col. Albert J. Wetzel:** Appointed Assistant to the Commander, Ballistic Systems Division, Air Force Systems Command, Los Angeles. As assistant to Maj.

**Gen. T. P. Gerrity**, Commander, BSD, Col. Wetzel brings to this position years of experience in the field of guided missiles. Because of his long service as director of the *Titan* guided missile program, he is generally known as "Mr. Titan."

**John C. Barnes:** Named vice president, Hycon Mfg. Co., Monrovia, Calif., Barnes formerly was assistant to the chief scientist and acting director of the laboratories at North American Aviation's Space and Information Systems Division.

**James L. Kimball:** Project engineer for Cohu Electronics, Inc., Kin Tel Div., San Diego, promoted to assistant chief engineer. He will coordinate all engineering activities for Kin Tel.

**Donald Ramaker:** Development engineer, Hamilton Standard, div. of United Aircraft Corp., Windsor Locks, Conn., promoted to chief of design of the engineering dept.

**Clarence H. Lewis:** Appointed manager, Westinghouse's Astroelectronics Laboratory, Conejo Valley, Calif. Lewis replaces **J. E. Darr**, who is returning to the Air Arm Engineering Dept., Baltimore.

**Donald Friedman:** Former engineering manager and military operations manager, ACF's Electronics Div., appointed head of Land Operations Dept., General Motors Defense Systems Div.

**Dr. Norman Lee Barr:** Named head of Biological Sciences and Systems Dept., General Motors Defense Systems Div., Warren, Mich. Dr. Barr formerly was Director of Aviation Medicine and Submarine Medicine Research and Deputy Director for Medical Research. He also served on the committee that established environmental control criteria for project *Mercury*, selected the *Mercury* astronauts and developed their training program.

**J. J. Rendos:** Appointed assistant manager, Cryogenic Engineering Dept., Air Reduction Sales Co., New York City.

**George R. Spitzer:** Appointed assistant to the president, Missile Systems Corp., Beverly Hills, Calif. Formerly Spitzer was

chief of support publications, Astronautics Div., General Dynamics Corp.

**Richard C. Koperek:** With the Hallamore Div., The Siegler Corp., Anaheim, Calif., since 1955, promoted to vice president and treasurer of Hallamore Div. and continues to serve as assistant secretary of The Siegler Corp.

**Charles E. Ducommun:** Los Angeles industrialist and civic leader, elected to the board of directors, Lockheed Aircraft Corp. Ducommun is president of Ducommun Metals & Supply Co., a director of Security-First National Bank of Los Angeles, and Pacific Telephone and Telegraph Co.

**Jack G. Anderson:** Formerly with General Dynamics/Electronics, joins Kollsman Instrument Corp., major division of Standard Kollsman Industries, as vice president of marketing.

**Dr. J. Gordon Wells:** Named assistant director of the life sciences department, North American Aviation's Space and Information Systems division, Downey, Calif. Dr. Wells formerly was with the Air Force School of Aviation Medicine, and supervisor of Northrop Corp.'s human engineering organization.

**Charles J. Ellis** and **Harry P. Gough:** Elected regional vice presidents, General Electric Co., for the Southeastern and Western regions, respectively.

**I. Nevin Palley:** Elected executive vice president, Curtiss-Wright Corp., Wood-Ridge, N.J. Palley joins Curtiss-Wright from ITT-Federal Laboratories, of which he was president.

**William A. Wildhack:** Former special assistant to the director, appointed associate director, National Bureau of Standards, Washington, D.C. He will be responsible for coordination of NBS measurement services to science, industry, other agencies of the Federal government, and the states.

**John R. Herring:** Former director of the program office, promoted to manager, Engineering and Production, West Coast Testing Div., Wyle Laboratories, El Segundo, Calif.

# contracts

## NASA

- \$3,996,129—Electronic & Missile Facilities, Inc., New York City, for construction of Marshall SFC's central laboratory and office facility, Huntsville, Ala.
- \$1,140,426—Chrysler Corp., Detroit, for engineering, design and construction of rocket components and facilities.
- \$1,000,000—Radiation Incorporated, Melbourne, Fla., from Grumman Aircraft Engineering Corp., for pulse code modulation (PCM) telemetry and special data handling equipment for *Orbiting Astronomical Observatory (OAO)* satellite.
- \$993,559—Radio Corp. of America, New York City, for development of a payload capsule for testing electric-propulsion engines.
- \$846,000—Flexonics Corp., Maywood, Ill., for design and fabrication of components in the *Saturn* pressurization and propellant feed-line system.
- \$177,000—Space Technology Laboratories, Inc., from Marshall SFC, for development of information on cost, assembly techniques and stability control of *Saturn* and *Nova* class space vehicles (three contracts).
- \$95,948—Hughes Aircraft Co., Culver City, Calif., for feasibility study of low-temperature thermionic energy converter for Lewis Research Center.

## MISCELLANEOUS

- \$17,000,000—The Martin Co., Orlando, Fla., from Air Force and Navy, for production of *Bullpup* air-to-surface missiles.
- \$1,690,392—Sperry-Rand Corp., Great Neck, N.Y., for production of attitude director instruments plus spare parts, aerospace ground equipment and technical data.
- \$400,000—Tele-Dynamics Div., American

Bosch Arma Corp., Philadelphia, from Sandia Corp. and Vought Electronics, for production of miniature telemetry components.

\$300,000—Institute for Scientific Information, Philadelphia, from National Institutes of Health and National Science Foundation, for study of the practicability of citation indexes and for testing their techniques of preparation.

Avien, Inc., Woodside, N.Y., from Astro-Electronics Div. of RCA, for modification to widen the frequency band of a multi-band tracking, telemetry and command antenna for *Tiros IV*. No amount disclosed.

Vitro Engineering Co., New York City, from AEC and NASA, for design and engineering for nuclear rocket engine maintenance and disassembly building, the first component of the National Nuclear Rocket Development Center, expected to be located at AEC's Jackass Flats, Nev., test site. No amount disclosed.

## NAVY

- \$42,400,000—Raytheon Co., Lexington, Mass., for production of *Sparrow III* missiles.
- \$17,405,000—Lockheed Aircraft Corp., Sunnyvale, Calif., for production of *Polaris* missiles.
- \$14,500,000—Sparton Electronics Div. of Sparton Corp., Jackson, Mich., for various types of sonobuoys.
- \$12,000,000—Sperry Gyroscope Co., Great Neck, N.Y., for navigation subsystem equipment.
- \$6,300,000—Motorola, Inc., Chicago, for production of sonobuoys.
- \$2,100,000—Thompson Ramo Wooldridge's Ramo Wooldridge Div., Canoga Park, Calif., from Johns Hopkins Univ. Applied Physics Laboratory, for shipborne com-

puters and data-processing equipment used in conjunction with the *Transit* program to facilitate position determination from satellite-transmitted information.

\$1,044,765—Lockley Machine Co., New Castle, Pa., for production of *Zuni* rocket launchers.

\$732,359—General Dynamics/Astronautics, Pomona, Calif., for facilities to meet production schedules for BT-3A and HT-3 *Tesla* and the improved *Tartar* missile program.

\$200,000—Arthur D. Little, Inc., Cambridge, Mass., from ONR, for research on infrared emittance of clouds.

Westinghouse Electric Corp.'s Electronic Div., Baltimore, from Johns Hopkins Univ. Applied Physics Laboratory, for initial portion of development of the shipboard receiver set for the *Transit* satellite navigation system. No amount disclosed.

## ARMY

- \$4,225,627—Armament Div., Universal Machine Corp., St. Louis, from ABMA, for transporter-erector-launchers (TEL) for *Perseus* missile (two contracts).
- \$1,400,000—Bendix Systems Div., Ann Arbor, Mich., for modification of *Advent* satellite communication system.
- \$1,011,788—Raytheon Co., Waltham, Mass., for concurrent repair parts for *Hawk* missile systems.
- \$242,000—Electro-Mechanical Div., Lear, Incorporated, Grand Rapids, Mich., from Sperry-Utah, for guidance-fin actuators for *Sergeant* missile.
- Atomics International Div., North American Aviation, Inc., Canoga Park, Calif., for R&D study for a "back-pack"-size power supply to generate electricity directly and operate on conventional fuels. No amount disclosed.

## AIR FORCE

- \$2,100,000—Western Electric Co., New York City, for work in connection with microwave communications at classified locations.
- \$2,000,000—Ampex Corp., Redwood City, Cal., from Electro-Mechanical Research, Inc., for magnetic memory systems for *Dyna-Soar* space glider project.
- \$950,000—Technical Operations, Inc., Burlington, Mass., for continued development of application of operations research and computer techniques for the study of aerial warfare on both global and tactical scales (Project *OMEGA*).
- \$600,000—Weber Aircraft Corp., Burbank, Calif., from The Boeing Co., for ejector seat and survival system for *Dyna-Soar* manned space glider.
- \$307,324—Avco-Everett Research Laboratory, Everett, Mass., from ASD, Wright-Patterson AFB, for study of a method to control maneuver and land a satellite in a predetermined area by varying the vehicle's aerodynamic shape in flight.
- \$210,000—Wyle Laboratories, from ASD, Wright-Patterson AFB, for evaluation of telemetry transducers.
- \$100,000—Rocketdyne Div., North American Aviation, Inc., for in-service engineering in support of *Atlas* weapon systems.
- \$95,000—General Electric's Missile and Space Vehicle Dept., Philadelphia, for initial provision of airborne and AGE spares for *Titan II*, Mark VI re-entry vehicle system.
- North American Aviation's Space and Formation Systems Div., Downey, Cal., for a study of applying the sandwiche structural design concept to a solid-rocket motor case or booster. No amount disclosed.
- The Siegler Corp., Los Angeles, for development of major one-piece tank domes for the *Titan II* ICBM. No amount disclosed.

# VORSTAC CONTACT OSCARS LIDAR GUSTO

These are new TRG systems for proximity warning, station keeping, collision avoidance, satellite guidance, long-range precision sonar, optical radar. Each program has significance, the feel of the future. It can be your future too, if you are an experienced engineer or physicist who can

"... try with spirit to reach the summit of excellence."

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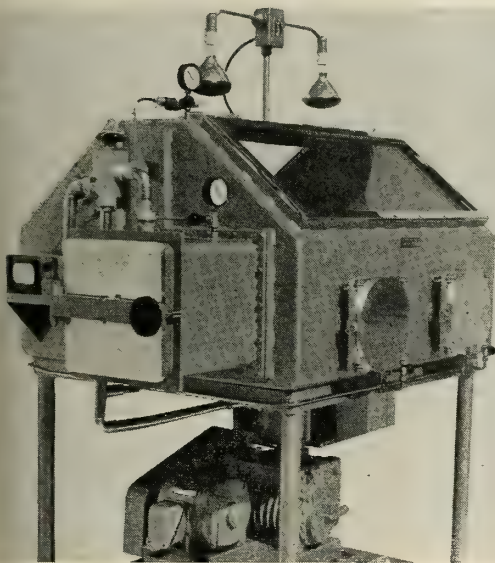
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## New Product of the Week:

### Royal's Inert-gas Box

A NEW INERT-GAS enclosure, believed suitable for explosives research and development, is now available from Royal-Research Corporation, Hayward, Calif.

Called the ERINGARD Model MkII, the unit is also designed for welding rare metals—such as molybdenum, tantalum, columbium and zirconium—which oxidize readily in the presence of normal air. Royal says selective inert gases can be used with this system.

A leak rate of less than 1 micron/minute, at a base

pressure of 1 micron, assures maximum purity of the working atmosphere, the company says.

Employing heavy steel-welded construction, the new unit is equipped with four 8-inch diam. glove ports that permit two operators to work simultaneously, either as a team or independently.

Other features include a 5-cfm mechanical pump, which produces an ultimate base pressure of 1 micron, a gas-tight interchange vestibule and an exterior mounted flood light. (Models are also available with a 15-cfm pump which will bring the pressure level to 1 micron in 20 minutes.)

The vestibule is equipped with hermetically sealed pump-outs, vacuum gauges and gas inlets, making it possible to move into and out of the box or main chamber without having to evacuate the latter.

A removable feed-through plate is provided at one end of the box for electrical, gas and water connections to the inside for use with a heliarc or similar type torch. Operating area temperature is kept at an acceptable level by a 1/3-hp refrigeration system.

An important work feature of the unit, says Royal, is the increased productivity achieved through the visual access and arrangement of controls. Further, the interchange vestibule can be evacuated independently of the main chamber, making possible a reduction in inert-gas consumption and considerable savings in operating costs.

The unit measures 48 in. wide x 78 in. long x 64 in. high. The enclosure is 40 x 40 in. square and has a maximum working headroom of 26 in. Viewing windows are 16 x 37 in. Height to center of glove port is 42 in., while interchange vestibules are 12 in. by 13 in. deep.

In addition to the explosive and rare-metal-welding applications mentioned above, it also is expected to find wide use in such diverse fields as chemical production and pharmaceutical research and production.

Circle No. 225 on Subscriber Service Card

## Solid-State Limit Switch

A limit switch featuring solid-state electronics and high reliability has been introduced by the Apparatus Division of Texas Instruments, Inc. A life test that commenced several months ago is continuing, with the switch nearing 10,000,000 trouble-free cycles. The Stationary Limit Switch has no make-or-break electrical contacts and may be used in any application where roller-actuated switches are now employed. The high reliability makes it particularly useful for position indicating and limiting, safety interlocks and similar applications.

Circle No. 226 on Subscriber Service Card

data channels from a single 3 kc voice channel. Maximum transmission rate is 75 bits per second, equivalent to 100 words a minute in teletype operations, on each channel. The C-8102 modem communicates binary data for teletype, telemetering, remote control, telephone signalling and other applications. The system can operate unattended, since no operating controls are necessary. All or any of the 18 data channels can be supplied.

Circle No. 227 on Subscriber Service Card

## Two-channel Direct Writer

The Sanborn Co. is producing Model 296, a compact two-channel direct writing oscillograph which can record an extremely wide variety of d-c to 125 cps variables, using a pair of plug-in preamplifiers.

The system accepts any of the

"350" series interchangeable preamplifiers: Carrier; d-c coupling for 1.0 mv/div or 5.0 mv/div recording; Phase Sensitive Demodulator; differential d-c; logarithmic; frequency deviation; and low level, with plug-in elements for general purpose d-c recording with or without zero suppression, or for excitation and detection of d-c strain gage bridges.

The preamp signals feed a dual-channel driver amplifier/power supply which drives a pair of rugged, velocity feedback-damped galvanometers. Immediate readout recording is produced by heated styli on Sanborn rectangular-coordinate permapaper charts with 50-mm channels.

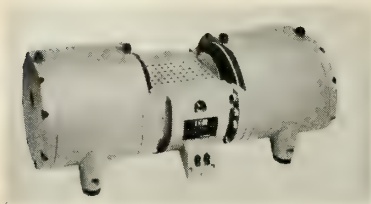
Circle No. 228 on Subscriber Service Card

## Vibration-Shock Tester

The Industrial Products Division of International Telephone and Telegraph Corp. is marketing a combination vi-

## Voice Band Modem

Collins Radio Co. has available a C-8102 FSK voice band modem, a multiplexing system that provides up to 18



bration- and shock-testing instrument, designated the ST300, which features a 250-force-pound air-bearing exciter for testing large components and sub-assemblies.

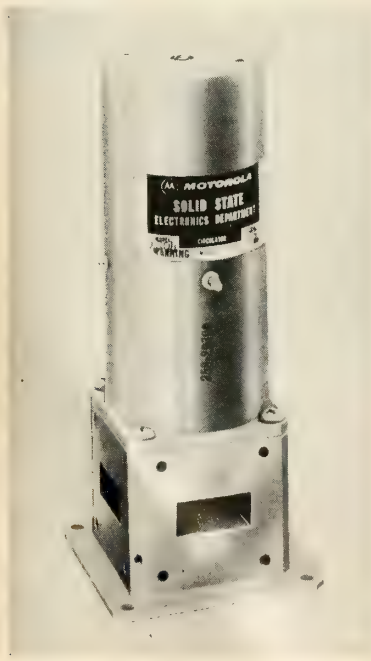
The instrument enables shock-testing to over 5000 g and vibration testing over a useful frequency range from 5 to 30,000 cycles. The first major resonance is above 6000 cycles.

The vibration exciter employs air bearings to support the moving element. This avoids problems inherent in the use of springs and flexures and thus makes possible an unusually flat response over a wide range of frequencies, permitting precise testing without the complications of compensating devices. Testing time and costs can be substantially reduced when shock and vibration are tested on the same instrument.

Circle No. 229 on Subscriber Service Card

## X-Band Turnstile Switch

The Motorola Solid State Electronics Department is marketing Model XS04 X-band turnstile switch. Based on the turnstile circulator, the switch con-



sists of two crossed rectangular waveguides with a 45° Faraday rotator in a shorted circular waveguide section which is orthogonal to the broad wall of the rectangular guides.

A signal at port no. 1 is transmitted to port no. 2 with ports 3 and 4 decoupled; a signal at port no. 2 is coupled to port no. 3, etc. To obtain the switching function, the direction of circulation is reversed by reversing the magnetic field applied to the Faraday rotator.

Circle No. 230 on Subscriber Service Card

## Flat Conductor Cable Connector

The National Connector Corp. has in production a flat conductor cable connector designed so that it may be used without soldering or splicing individual wires in flat conductor cable. The connector is relatively uncomplicated in construction and possesses many features not found in other flat conductor cable connectors now on the market. Designed for high reliability and positive locking characteristics under conditions of stress, the connector was designed for applications in data processing and readout systems. A quick connect-disconnect type, the connector consists of two high impact plastic mating halves which are attached to stripped ends of the tape by welding, soldering, crimping or mechanical pressure. The contacts may be removed from the connector for assembly to the conductor of the flat conductor cable.

Circle No. 231 on Subscriber Service Card

## D-C Countermeasure Blocks

Two d-c blocks, covering a frequency range of 1 through 7 kmc, have just been developed by the Weinschel Engineering Co. These blocks, Models 875 and 876, are particularly designed for use on countermeasures systems where components are permanently installed. The Model 875 has a frequency range of 1 through 2 kmc with a maximum insertion loss of 0.3 db. The maximum vswr is 1.25. The Model 876 has a frequency range of 2 through 7 kmc with a maximum insertion loss of 0.4 db. Its maximum vswr is 1.30.

Circle No. 232 on Subscriber Service Card

## Multi-Tube Furnace

Lindberg Engineering Co. is marketing a four-tube diffusion furnace with a detachable automatic pusher mechanism. The furnace reaches a maximum temperature of 1300°C in its 30 in.-long heating chamber, and has

a rated uniformity of 18 in.  $\pm 1.0^\circ\text{C}$ .

It is operated by two zones of control. Each zone has 12 globars, a 9.0 kva tapped-element transformer, a platinum-13% rhodium controlling thermocouple, and a Wheelco proportioning controller to indicate and control the temperature in each zone. Dimensions of the furnace and base only are 37 in. wide, 75 in. high and 52 in. long. Addition of the pusher mechanism increases the length to 91 in.

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## S, C and X-Band Measurements

Accurate measurement of frequencies in the S, C and X-Bands is readily obtainable with a panel-mounted unit, incorporating a series of tunable band-



pass filters, available from Frequency Standards. Insertion loss of the tunable filter in each of the bands (including a low-pass filter, bandpass-filter adapters and interconnecting line) is less than 4 db average. Absolute accuracy of the calibrated frequency is  $\pm 0.01\%$ . Bandwidth at 11 and 9 mcs is 3 db down and 0.25 db down, respectively. Spurious responses are eliminated by a low-pass filter, and tuning is achieved by a single duo-dial counter.

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## Fiber-Optic Cathode Tube

Faceplates using developments in fiber optics combine with high-resolution electron guns to significantly increase the resolution and brightness of new cathode ray tubes produced by Electronic Tube Corp.

In place of the usual glass faceplates, the tubes have insulated bundles of tiny glass fibers that eliminate the halation caused by excitation of neighboring phosphors, prevent refraction and improve light transmission as much as 80 times over standard CR tubes. This, in combination with special high resolution electron guns, makes it possible to reduce spot size to a dimension that greatly increases the usefulness of CR tubes for data display, radar, mapping and other exacting applications.

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## —when and where—

### OCTOBER

- 7th National Communications Symposium, IRE Professional Group on Communications Systems, Utica, N. Y., Oct. 2-4.**
- IRE Canadian Electronics Conference, Automotive Bldg., Exhibition Park, Toronto, Oct. 2-4.**
- XII International Astronautical Congress, hosted by American Rocket Society, Washington, D. C., Oct. 2-7.**
- 8th Annual Science & Engineering Symposium, AFSC and Aerospace Research, Sheraton-Palace Hotel, San Francisco, Oct. 3-4.**
- 9th Annual Human Engineering Institute, Stamford, Conn., Oct. 3-6.**
- American Society of Photogrammetry Semi-annual Convention, Biltmore Hotel, New York City, Oct. 4-6.**
- 17th National Electronics Conference and Exhibition, International Amphitheatre, Chicago, Oct. 9-11.**
- National Aeronautic and Space Engineering and Manufacturing Meeting, sponsored by Society of Automotive Engineers, Hotel Ambassador, Los Angeles, Oct. 9-12.**
- Space Flight Report to the Nation, American Rocket Society, New York Coliseum, New York City, Oct. 9-15.**
- Symposium on Shock, Vibration and Associated Environments, sponsored by DOD, Office of Director of R&E, Detroit, Oct. 10-12.**
- Optical Society of America Meeting, Somerset Hotel, Boston, Oct. 12-14.**
- 17th Annual ISA Instrument-Automation Conference and Exhibit, New York Coliseum, New York City, Oct. 15-19.**
- Second International Congress, International Organization for Vacuum Science and Technology, Eighth Annual Symposium of the American Vacuum Society, Washington, D. C., Oct. 16-19.**

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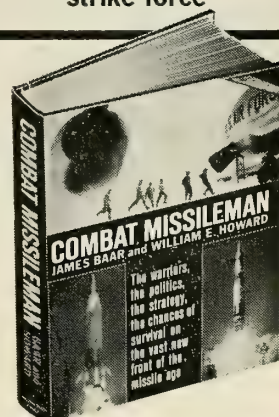


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## Fall Forecast: Faster and Warmer

**I**T IS WITH considerable relief that we note the Administration finally is stepping up its planning for both military and civilian space programs. The pace this year has been entirely too slow.

But there is a fall quickening all along the line.

The National Aeronautics and Space Administration is moving to get its big *Apollo* program under way. The NASA reorganization which is reported in this issue is designed to streamline the agency for management of the civilian man-in-space effort. The shuffle brings RCA's D. Brainerd Holmes into the NASA organization as the man who will, in effect, be the Czar of the *Apollo* project. We are pleased at the initial indications that NASA intends to give him the authority to get on with the job. The management setup is a compromise over the special projects office recommended by many in industry. But it is not the organization chart that counts as much as how it works.

It appears that Mr. Holmes may have "special project" authority even if his directorate does not bear that title. That's the important thing, together with the director's willingness to delegate authority where this is necessary. One of the things that made the *Polaris* special project approach work well was the willingness of the man at the top to let his subordinates make many of the important decisions. And Heaven help them if they made the wrong one!

From talking to his colleagues at RCA, we gather that Mr. Holmes may be just such a leader. We are pleased to report that he is highly thought of by those who worked with and for him.

It is significant that Mr. Holmes comes from RCA. He is one of the management men who have grown with the missile/space industry, rather than with its earlier parent, the aircraft industry. He may, as a result, be in a better position to deal with the complex management problems of the lunar program. You will find on page 17 a list of the top 25 NASA contractors in Fiscal '61. It is interesting to note that of these, only seven can even remotely be identified as aircraft firms. It is a measure of the growth which has taken place in a very few years.

Concurrently with the reorganization of NASA comes a stepped-up recruiting drive which will see the agency grow to well over 21,000 employees in the near future. This growth undoubtedly is necessary as NASA responsibilities are enlarged and as the lunar program develops. It is a growth which should be kept carefully in hand, however. The temptation to empire-build is a strong one.

We are concerned over some early indications that NASA is being tempted at the thought of in-house, as contrasted with industry, management of phases of the *Apollo* program. We refer you to the Letters column for further thoughts on this line. We

hope Mr. Holmes will make an early review of the decision on *Apollo* guidance one of the first items on his NASA calendar.

With the increasing pace of activity at NASA comes an indication that the National Aeronautics and Space Council headed by Vice President Johnson may be taking a more active role in direction of the nation's space affairs. Little has been heard of the organization since President Kennedy's decision to give it an active role in the policy-making of the Administration.

But it develops that the NASC has played a quiet part in a number of space decisions in recent months. As cited by its executive secretary, Dr. Edward Welsh, these include:

- The decisions to activate the big booster programs and the *Apollo* lunar program.

- Drafting of the new Air Force program for large solid boosters.

- Approval for inclusion of the nuclear auxiliary power unit in a space probe.

- The communication satellite decision which puts a commercial system in the hands of the international common carriers.

- Approval of plans for the Project *West Ford* communications experiment involving a net of needle-like particles in earth orbit.

**I**T IS REASSURING to know that an agency directly responsible to the President is taking part in decisions concerning space which cut across the duties of a number of other government bodies—from Air Force to FCC to NASA to the Weather Bureau.

The stepped-up Air Force drive for a bigger role in the space program also is a welcome end-of-year development. This is an absolute must, as this magazine has insisted for several years. The reasons were clearly spelled out in the symposium at the Air Force Association's Philadelphia meeting. We must be prepared to meet any Russian military threat in space. For very sound arguments on this subject, we refer you to the remarks on p. 12.

As expressed in Philadelphia, the idea of simply hoping for military fallout from a civilian space program seems a clear case of cart-before-the-horse in the light of Soviet activities. There must be a clear effort to assure military benefits.

It is heartening to know that talks now are under way to improve coordination at the "interface" between NASA and the Air Force.

All in all, the fall prospects are more encouraging than the picture during a lethargic summer and spring. We look ahead to a busy winter for the industry.

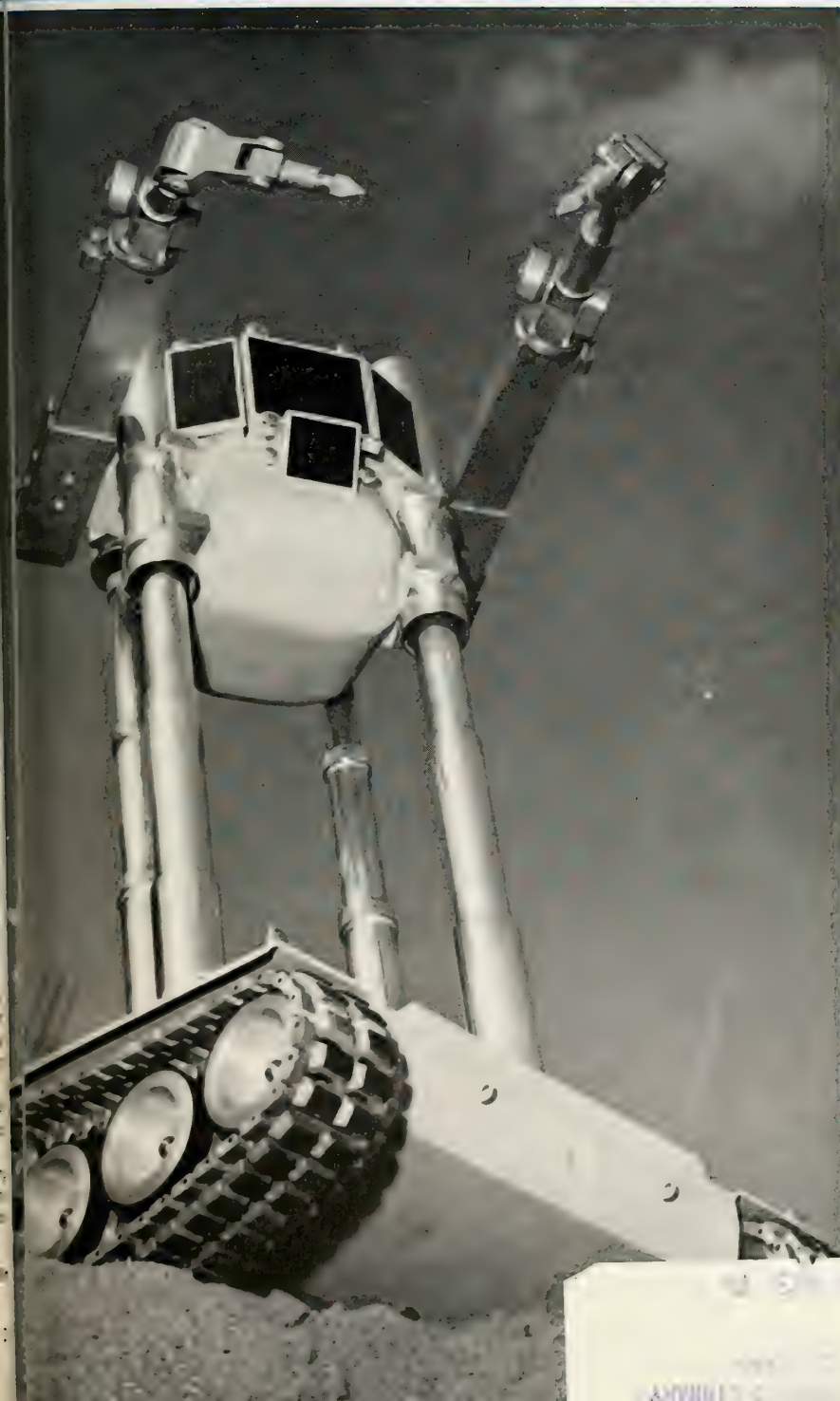
William J. Coughlin



OCTOBER 9, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

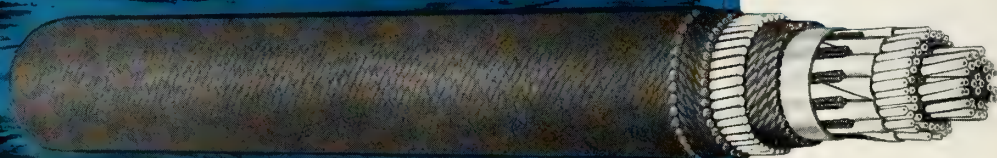
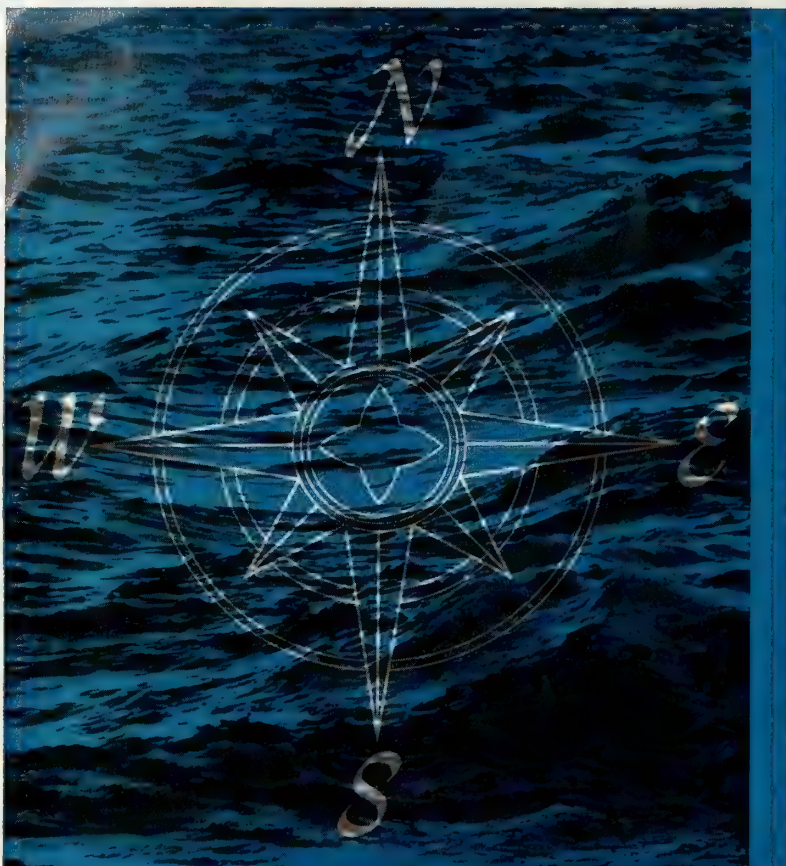


## R&D for Arms Control Will Cost Millions of Dollars

- U.S. to Push  
Rendezvous Plan
- NASA Revises  
Patent Proposals
- Mercury's  
'Pilot' Controls

GE's 'Beetle'

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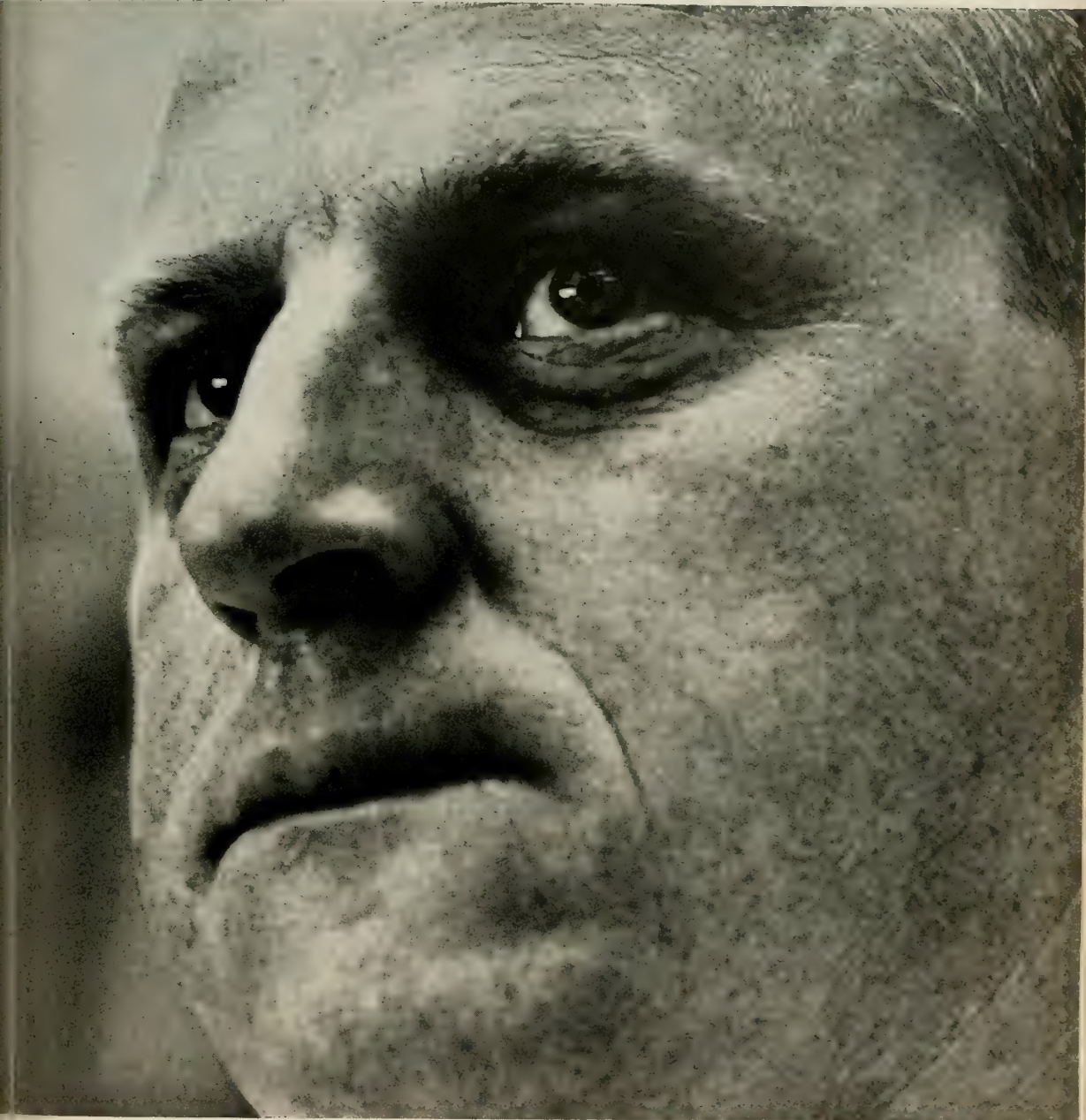
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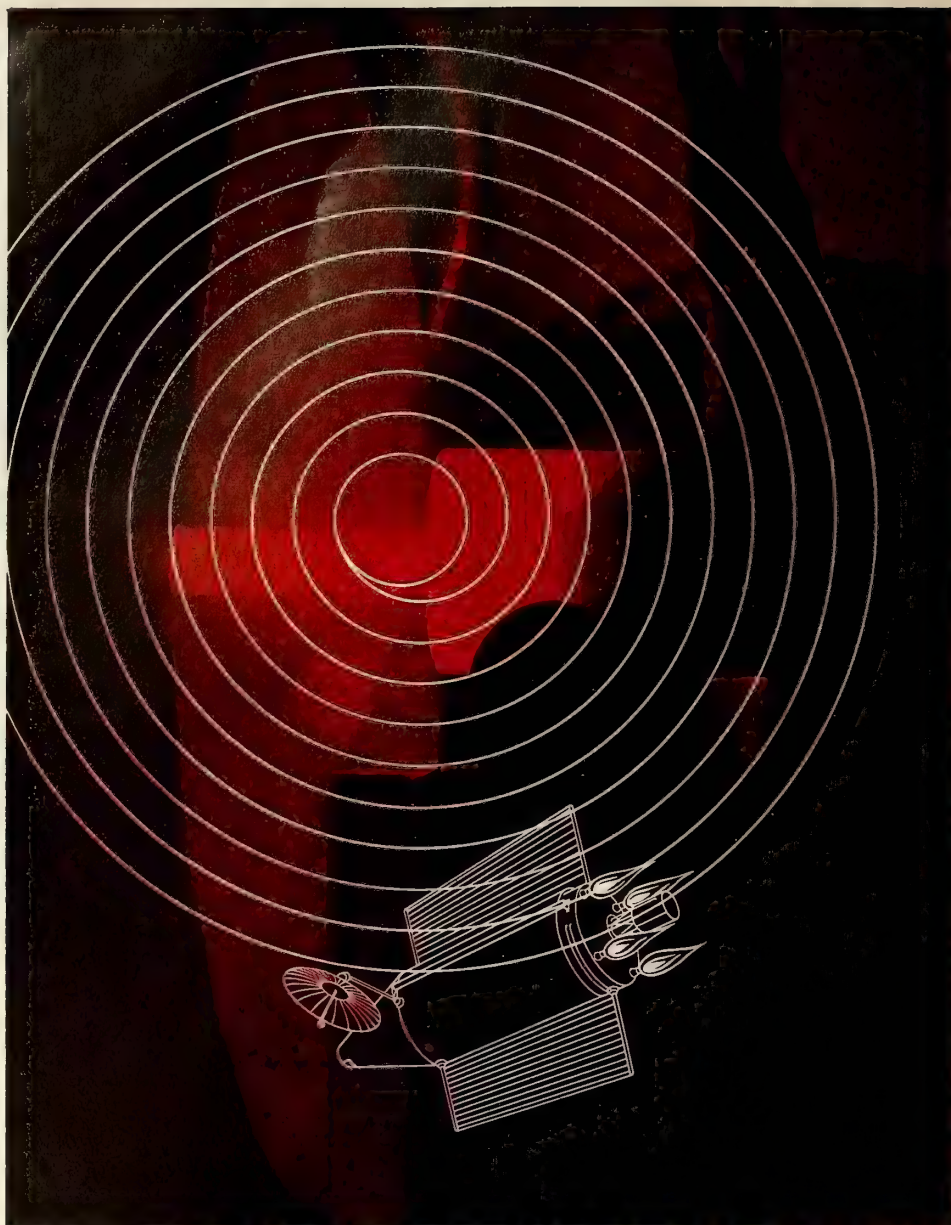


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October 9, 1961

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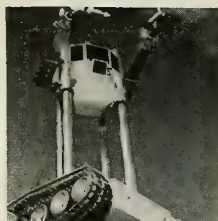
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**THE COVER**

*One-tenth-scale model of GE's "Beetle" moves across desert terrain. Eighty-ton shielded vehicle will handle radioactive equipment for the Air Force. See p. 39.*

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\*U.S. Reg.

†U.S. Reg. Pdg.

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## SUPPORT FOR THE SPACE AGE

Since the early days of "wireless" Blaw-Knox has been designing, fabricating and erecting towers and special structures to support equipment used to penetrate space. This long experience with the problems involved in this field is the reason systems companies and governmental agencies continue to utilize Blaw-Knox specialized facilities.

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## letters

### 'Non-Profit' Defender

To the Editor:

Your July 3 editorial ("Thoughts on Non-Profit Firms") is both encouraging and commendable. It's about time someone with courage spoke up to the politicians in this respect. The job couldn't be done "in house"—i.e., civil service military installations—with certain exceptions. Unfortunately, many are incapable of managing themselves efficiently and effectively, let alone a major weapon system. A few private industrial firms are no better off.

However, these "non-profit firms" and for that matter most defense industries, including some government facilities, have worked and are working to achieve the successful and timely development of our major weapon systems in the interest of National Security. Can the same be said about the House Appropriations Committee?

Before the Committee criticizes and denounces the intent of these "non-profit firms," and unjustly accuses them of salary infringement and other (misdeeds), it ought to clean its own house.

I suggest that they stick to politics and leave the National Defense to us.

If they have not read your editorial or magazine, I'd be willing to pay for their subscription so they can be enlightened.

Syl C. Piccoli  
General Manager  
Triad Associates  
Philadelphia

### An Eye for an I

To the Editor:

Many times I have noticed that you refer to the Field Army Ballistic Missile Defense System as *FABMIDS*. Why the "I"?

M. M. Watkins  
R&D Operations  
Army Rocket and Guided  
Missile Agency  
Redstone Arsenal, Ala.

*Mr. Watkins is technically correct. M/R spells it with an "I" as an aid to the correct pronunciation. So do quite a few Army officials at the Pentagon.—Ed.*

### Magazine for Secretaries

To the Editor:

As secretary to the manager of a group that is directly concerned with meteorological sounding rockets and upper-atmospheric measurement systems, I have made it a practice, encouraged by my boss, to become acquainted with the trade magazines in our field, and *MISSILES AND ROCKETS* gets my vote as the most outstanding. I have found that by reading these magazines I have become a more competent secretary, and of far more value to my boss than just a machine to take and transcribe dictation. I admit that I don't understand a lot of the technology

being discussed, however I feel there is no better way to obtain a general knowledge of the developments taking place in the industry today.

I have discussed with several people the possibility of a magazine aimed at the many secretaries concerned with the missile field and/or those laymen who are also interested. I realize that circulation would have to be very widespread to warrant a magazine of this type, but I, for one, would be willing to spend \$5.00 per year to help me become better informed about the field in which I am working, and to be able to converse more intelligently with the many people with whom I daily come in contact. If a company realizes how much more a well-informed secretary is worth, and how much more enthusiasm for her job is generated by knowledge of and an interest in her field, I imagine it might be willing to spend a few dollars a year (which would be no turned many fold) on such a magazine.

Perhaps this idea is not feasible, but it's something that I and other of my secretarial friends support wholeheartedly.

Jere M. Noble  
Secretary to the Manager  
Astro Measurements  
Gulton Industries, Inc.  
Hawthorne, Calif.

### Camera in Focus

To the Editor:

**NORTHROP TECHNICAL STAFF EXTENDS CONGRATULATIONS TO MR. (CHARLES D.) LAFOND FOR EXCELLENT REPORT ON 600 M BALLISTIC CAMERA ("AMR Buys Best Ballistic Camera," M/R, Sept. 11, 32). HIS STORY IS FACTUAL AND ACCURATE, A CREDIT TO HIM AND THE EDITORIAL STAFF OF MISSILES AND ROCKETS.**

MARC NAULT  
NORTHROP CORPORATION  
HAWTHORNE, CALIF.

To the Editor:

I enjoyed the article very much, but I cannot refrain from making some comments on it. I would like to pass a few of these on to you:

1. The Nortronics ballistic camera is not the biggest ballistic camera ever built unless one considers only sheer size and weight; the ICF PC-1000 now in use at several government agencies has a focal length of 1000mm, 400mm longer than the Nortronics camera. As you know, focal length and distortion are the prime factors in determining the accuracy of a ballistic camera, not the weight.

2. The ICF PC-1000 has a minimum accuracy of 1 part in 200,000 and is well equipped of linear and angular accuracies of 1 part in 500,000—that is, it is expected to locate a missile within ten to fourteen feet at a distance of 10 miles.

3. The Nortronics camera is certainly a fine camera, but it is not the best for missiles and rockets, October 9, 1964



the first of its type built in the U.S., unless, again, you consider sheer weight. 4. The cost of six PC-1000 ballistic cameras would be less than the cost of the Nortronics cameras. . . . I feel that the article, in general, was good one, especially in the description of the application of ballistic cameras to missile tracking, although the geodetic structure measurement applications are omitted. But, in the area of Com- my claims, I feel the article strayed somewhat from the facts. . . .

Charles M. Worthley  
Sales Manager  
Instrument Corporation of Florida  
Melbourne, Fla.

## Support for Crater Theory?

the Editor:  
You may not be aware of it, but the photograph published on page 24 of the Aug. 28 M/R sheds some light on a problem that has long puzzled selenographers.



RAY PATTERN from Ranger impact.

To date, there has been no satisfactory explanation of the rays extending from a set of the larger craters on the moon. The photograph showing the results of dropping a Ranger capsule from an altitude of 1000 feet to a macadam surface reveals an interesting pattern of rays extending from the impact crater. The photo inadequately supports the theory that the moon craters were formed by meteoric impact. So it seems that even before the Ranger program has had a successful launch, it has contributed something to our knowledge of the moon.

Benjamin W. Bova  
Avco-Everett Research Laboratory  
Everett, Mass.

## What Time is It?

the Editor:  
In your excellent, multi-colored ad in the center of M/R, pages 26 and 27 of the August 28th issue, the time at Colorado Springs appears to be 09:16 on the display board. But look at the clock under the three men in the observation balcony—it reads 7:57 or 7:58. Do you understand the picture, or did this sneak in?

Charles L. Goodell  
Staff Assistant  
Space Sciences and Propulsion Division  
Stanford Research Institute  
Menlo Park, Calif.

missiles and rockets, October 9, 1961



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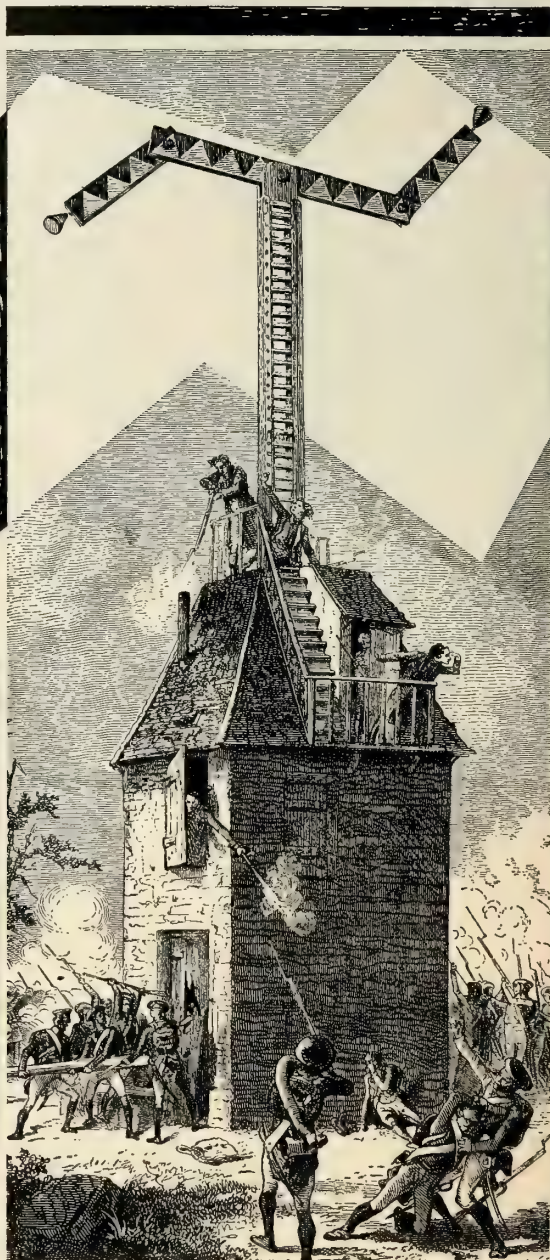
**LONG RANGE INPUT/1794** / News of the recapture of Condé from the Austrians was sped to the French Revolutionary Convention at Paris in a matter of minutes via Claude Chappe's amazing télégraphe aérienne, or relay aerial telegraph, Sept. 1, 1794. A new era in rapid communications had begun. / Today, instantaneous and completely reliable Electronic Communications insure the immediate and continuous interchange of intelligence throughout the Free World. ECI is proud of its initiative and responsibilities in the design, development and manufacture of high precision electronic equipment to the critical specifications required in various aerospace and surface roles vital to our National Defense and to scientific achievement. An example is ALRI—Airborne Long Range Input—a program where ECI communications and data link equipment fill an integral and essential requirement in linking USAF's advanced early warning system to SAGE—our continental defense network.



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# The Countdown

## WASHINGTON

### Fiscal '63: What's Coming

Here is how some of the key FY '63 program decisions flowing from Defense Secretary McNamara's office are said to look: For the Air Force—about two additional fixed-base 50-missile *Minuteman* squadrons to bring the total authorized squadrons to eight. Also, some new R&D money for mobile *Minutemen*—but no production go-ahead. For the Navy—about seven more *Polaris* submarines, to bring the total to about 36. For the Army—continued underwriting of much of the limited-war buildup; continued R&D for *Nike-Zeus* but no production okay.

### New Apollo Date Official

NASA Administrator James E. Webb says the current timetable for the U.S. lunar program calls for a manned landing in 1967-68. This is the first official confirmation that NASA has cut the target date from the oft-quoted "sometime before the end of the decade." Webb also confirms that the U.S. space program in Fiscal '63 is expected to cost at least \$3.5 billion. And he says the agency will go back to Congress early next year in an attempt to get a supplemental appropriation to replace a Congressional cut of \$112 million in the Fiscal '62 budget.

### Monitoring Soviet Missilery

No one in Washington is ready to swear to the accuracy of the latest series of Soviet missile shots into the mid-Pacific because no one is sure of the bull's-eye. But each shot has been carefully monitored as it re-entered and impacted.

### Nike Missile Accuracy

Insiders say *Nike* missile units firing at McGregor Range in New Mexico are missing their targets in two out of every ten firings.

### Reduction in Mariner's Weight

NASA confirms that the weight of the *Mariner* spacecraft will be cut from 1100 lbs. to 400 lbs. for a Venus launch next year. Reduction was forced by the shift from *Centaur* to an *Atlas-Agena B* due to slippage in the *Centaur* program. (M/R, Sept. 4, p. 12).

### More Atlases Combat-Ready

The number of operational *Atlases* is scheduled to reach about 45 in a very few weeks. One new nine-missile squadron at Fairchild AFB, Wash., was turned over to SAC last week. Another—at Forbes, Kan.—is expected to go operational in mid-October. In addition to these, a total of some 27 *Atlas* missiles are listed as operational at Vandenberg, Warren and Offutt Air Force Bases.

### Titan I Still Slipping

Latest tentative operational date for the first Air Force *Titan I* squadron—nine hardened sites at Lowry AFB, Colo.—is November. Even that may slip into December. The *Titan* complex at Lowry originally was scheduled to be operational in mid-1961, but it has been plagued by strikes and other difficulties.

missiles and rockets, October 9, 1961

## NASA Cuts Calorie

NASA has killed plans for Project *Calorie*—designed as a re-entry test for materials to be used in the *Apollo* spacecraft. It would have used *Atlas-Agena B* as the launch vehicle. Officials say the shot would not have provided the necessary velocity. Instead, *Saturn C-1* with a payload of a boilerplate *Apollo* spacecraft will be used for the same test.

## ComSat Report on Schedule

Although there have been rumbles of conflict among the members, the ad hoc committee of international communications carriers set up to recommend an ownership plan for a commercial communications satellite system will submit its report on schedule. The committee has clamped a secrecy lid on the report. There will be no public announcement of the contents until it is in the hands of the Federal Communications Commission. Deadline: Oct. 13.

## INDUSTRY

### S-1<sup>b</sup> Engine Choice Deferred

Proposals for development of the S-1<sup>b</sup> stage of the *Saturn* booster were handed to industry representatives in New Orleans last week. The firms were told that the stage would have two or four liquid F-1 engines. NASA said a final decision on number of engines will be made before companies get too deep into preparing bids.

### Pershing GSE: How Much?

Cost of GSE for the Martin *Pershing* always has been a closely-guarded figure. Price tags on the individual items are kept well disguised in total figures. Now, at least, the price of the *Pershing* launcher made by Universal Match has been disentangled. The launchers cost about \$110,000 each.

### Saturn Launch Delayed

Technical difficulties forced some slippage in the first launch of the *Saturn C-1* from Cape Canaveral. It's now scheduled to go sometime next week. *Ranger II* also is to be launched from the Cape later this month.

## INTERNATIONAL

### Nyet to New York

Request of nine Soviet space scientists attending the IAF meeting in Washington for visas which would permit them to take in the big American Rocket Society meeting in New York this week was turned down. Official reason: The Soviet Union has ignored requests that American scientists be permitted to attend a similar space meeting in Moscow. Unofficial reason: Fears they might be in a position to score a propaganda coup if a Soviet space spectacular comes off this week.

### Jodrell Bank for Early Warning

Delay in building the BMEWS station at Fylingdales Moor, England, has resulted in a decision to use the Jodrell Bank radio telescope for early warning. Equipment for this will be installed shortly. A succession of strikes has held up work on the Fylingdales station.

# The Missile/Space Week

## Apollo: Then There Were 5

Only five firms will be competing for the prime contract on NASA's multimillion-dollar *Apollo* spacecraft program when bids are submitted to the space agency this week.

The five are General Electric, Martin, North American Aviation, General Dynamics/Astronautics, and McDonnell Aircraft Corp.

NASA invited 17 firms to bid on the contract for the command module for the spacecraft and the systems engineering for the total spacecraft development program. The organization of bidder teams cut the total to only five.

GE's team includes Douglas, Grumman, and Space Technology Laboratories.

The McDonnell team is made up of Chance Vought, Hughes, Lockheed, and Aerojet-General.

The General Dynamics team will include Avco. Martin and NAA have not set up a team, although other firms would take part if either were awarded the contract.

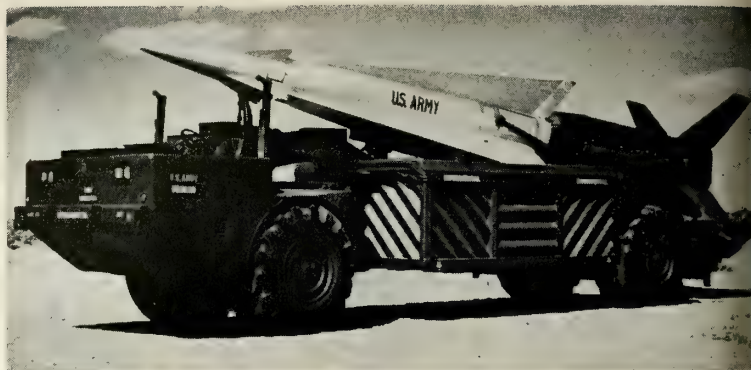
A big surprise was Boeing's decision not to bid for the spacecraft contract. The firm announced that it was foregoing the opportunity to bid in order to concentrate its efforts on getting one of the contracts for the development of the *Saturn* Booster.

Other invited firms which did not bid or were not able to get on one of the "teams" included Republic, Bell Aerospace Systems and RCA. No disclosure has been made as to whether Goodyear will submit a bid. RCA reportedly will work with Martin if that firm gets the prime contract.

While NASA has permitted the firms to establish bidding teams, it is not restricted to their lineups. It has reserved the right to reshuffle the teams "to make itself the best deal possible."

## Shots of The Week

- An *Atlas* plopped into the South Atlantic Oct. 2, 5000 miles from its Canaveral launch site. Aboard were two pods, one containing pyrotechnic packages to simulate fuel cores that later will be used in



*FIRST LAUNCH* of a Nike-Hercules from an experimental mobile transporter, reported last week, showed the potential mobility of the anti-aircraft weapon.

nuclear-powered generators aboard satellites, the other carrying the inertial guidance system being developed for *Centaur*. The pods were recovered by the Ocean Range Vessel Timber Hitch.

- The Army announced on Oct. 2 the first successful firing of its *Nike-Hercules* from a new mobile battlefield transporter, the experimental Goer vehicle, during a simulated combat mission at White Sands Missile Range (see photo).

- The *X-15* was flown minus one of its four stabilizing fins on Oct. 4 in a test of the craft's manual stabilization control. For two minutes of the nine-minute flight, the entire stabilization system was turned off to simulate failure. Said pilot Robert Rushworth: "all went well".

An earlier flight on Sept. 28 checked out high-temperature capabilities. Navy Comdr. Forest S. Petersen was at the controls.

- An advanced thrust-control system was tested on the 200-mile flight of a *Polaris* fired from Cape Canaveral on Sept. 29. The Navy described it as an "advanced device being evaluated for possible use in the third-generation A-3 *Polaris*." The use of freon injection is under study for the 2800-mi. A-3 and the longer-range A-4. The plug nozzle also is under study for the A-4.

- An A-2 *Polaris* was launched on a 1500-mi. flight from the deck of the USS Observation Island off Cape Canaveral on Oct. 4, marking the fourth success in seven shipboard firings of the model. It has an 8-2

record in launchings from pads at the Cape.

- Sperry's *Sergeant* missile successfully completed the contractor's R&D test firing phase of its program in a number of launchings over the past two weeks, the Army reported. Production of the missile is well under way at Sperry's Salt Lake City, Utah, plant.

## Biggest ARS Show

More than 15,000 scientists and engineers are expected to attend American Rocket Society's "Space Flight Report to the Nation" this week in New York.

Some 175 missile/space firms are participating in what is termed the largest exhibit of space flight system subsystems, components, equipment materials and processes ever held.

Highlight of the week is to be an address by Vice President Lyndon B. Johnson at Friday evening's banquet.

Exhibits will cover 95,000 sq. ft. on three floors of the New York Coliseum. They will include: Rocketdyne's exhibit of the eight-engine cluster of the *Saturn* first stage; the McDonnell *Mercury* capsule; Hughes Aircraft's cesium ion engine; B. Goodrich's spherical solid-fueled motor; United Technology's conical segmented solid booster; and *Courier*, *Transit*, *Echo* and *Advent* satellites.

More than 50 technical sessions will cover the scientific and engineering problems of space travel.

For the first time, the annual ARS display will be open to the public. There also will be public panel discussions.



essions as well as some lectures.

A Thursday evening panel on U.S. and Soviet space programs will include: Werner von Braun, Marshall Space Flight Center director; Lt. Gen. Bernard A. Schriever, commander, Air Force Systems Command; Hugh H. Dryden, deputy administrator, NASA; Arthur C. Clarke, noted author; Arthur Kantrowitz, vice president, Avco Corp.; and F. J. Krieger, Russian specialist, Rand Corp.

Dr. William H. Pickering, director of Jet Propulsion Laboratory, has been elected ARS president for next year.

### Rovers Urgency Asserted

Project Rover got a boost from speakers at opposite ends of the country last week. Addressing the International Astronautical Congress in Washington (see p. 14), Harold B. Fager, manager of the AEC-NASA Space Nuclear Propulsion Office, described nuclear propulsion as a necessity for manned interplanetary flights. He said the contract for a RIFT (re-entry in flight test) vehicle will be let after the beginning of 1962. He confirmed plans for a 1966-67 flight test date for NERVA, the first U.S. nuclear engine for rocket vehicle application. Launch is to be with a Saturn-class first stage.

Meanwhile, in California Rep. C. P. Holifield (D-Calif.), chairman of the Joint Congressional Committee on Atomic Energy, asserted that the only hope for passing the Russians in space flight lies in nuclear propulsion. He said the U.S. may end up in a "sorry second" if Project Rover is not pushed.

### Predictions of the Week

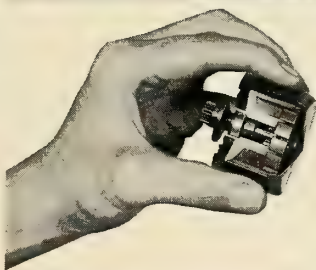
When Soviet space scientist Leonid Sedov was asked at the IAF meeting to predict which country will have the first astronaut on the moon, he gave the matter serious thought and then replied: "Information on this is very limited." Then he smiled.

A lunar international laboratory (IL) will be established for moon research within 25 years, according to Dr. Theodore von Karman. It already is being planned by the International Academy of Astronautics, which he heads. Also predicted: that rocket flights to the moon by then will be as commonplace as a jet airplane trip from New York to Paris today.

missiles and rockets, October 9, 1961



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# Arms Control Agency W

**SOME OF the areas in which the new Arms Control and Disarmament Agency will conduct R&D and studies:**

■ *Detection, identification, inspection, monitoring, limitation, reduction and control of armed forces and armaments including nuclear weapons, missiles and CBR.*

■ *Techniques of detecting, identifying, inspecting and monitoring tests of nuclear and other weapons.*

■ *Analysis of national budgets, levels of industrial production and economic indicators to determine the amount spent by various countries on armaments.*

■ *Control, reduction and elimination of armed forces and armaments in space, in areas on or beneath the surface of the earth and under and on water.*

■ *Reduction and elimination of the dangers of war resulting from accident, miscalculation or possible surprise attack.*

■ *Methods of maintenance of peace and security during various stages of arms control and disarmament.*

■ *Scientific, economic, political-legal, social, psychological, military and technological factors related to the prevention of war.*

■ *Training of scientists, technicians and other personnel for manning possible arms control systems.*

■ *Economic and political consequences of arms control and disarmament including the problems of readjustment arising in industry and the reallocation of national resources.*

■ *Structure and operation of international arms control organizations.*

**by James Baar**

THE NEWLY-ESTABLISHED U.S. Arms Control and Disarmament Agency is expected to become the control center for a highly diverse, multimillion-dollar R&D program which will offer extensive contracting opportunities for the missile/space industry.

For the first time, the government will put under one roof the many studies and R&D projects on arms control and disarmament that are now scattered throughout more than a half-dozen federal departments and agencies.

Moreover, the independent Arms Control Agency plans to expand greatly the scope of many of these projects and move into many areas that to date have been ignored or brushed over very lightly.

It is still much too early to estimate the size of the agency's program and budget for FY '63. However, an appropriation request of \$100 million or more is considered by some government officials to be on the conservative side.

The agency is all but certain to request a supplemental appropriation in January for the rest of FY '63, since only \$10 million was provided for the first year by the Arms Control and Disarmament Act that cleared Congress less than three weeks ago.

• **Sweeping power**—The authority granted to the agency to conduct R&D is extremely broad. It runs the way from the possible development of missile deployment monitoring systems to studies on the political and economic effects of various types of arms control agreements.

One potentially important R&D program which the agency is certain to initiate quickly—it was mentioned specifically in the Arms Control Act—is the development of improved communications links between senior levels of government.

Such a project would be aimed at reducing the risk of nuclear war being started by error. It also would provide the essential means for ending a nuclear war.

So far, no determination has been made as to which of the many arms control R&D and study projects now under way will be transferred to the Arms Control Agency. The principal agencies involved are the Defense Department, Atomic Energy Commission, Central Intelligence Agency, State Department, NASA and Commerce Department.

The total amount being spent annually by the



# Invest Many Millions in R&D

**Project Vela Funding—(in millions of dollars)**

|              | FY '60  |        |       |       | FY '61  |        |       |       | FY '62 (est.) |        |       |       |
|--------------|---------|--------|-------|-------|---------|--------|-------|-------|---------------|--------|-------|-------|
|              | Uniform | Sierra | Hotel | Total | Uniform | Sierra | Hotel | Total | Uniform       | Sierra | Hotel | Total |
| <b>DOD</b>   | 7.5     | .4     | .6    | 8.5   | 31.4    | 2.4    | 6.8   | 40.6  | 47            | 2      | 10    | 59    |
| <b>AEC</b>   | 5.9     | .2     | 1.2   | 7.3   | 13.4    | .4     | 1.9   | 15.7  | 18            | .3     | 2.1   | 20.4  |
| <b>TOTAL</b> | 13.4    | .6     | 1.8   | 15.8  | 44.8    | 2.8    | 8.7   | 56.3  | 65            | 2.3    | 12.1  | 79.4  |

**THE THREE VELAS:** Uniform is the detection of underground and underwater nuclear explosions; Sierra is the detection and identification by surface-based instrumentation of high-altitude

explosions; Hotel is the detection and detonation by satellite-borne instrumentation of high-altitude explosions.

agencies on arms control research has not been disclosed by the government because of security and the simple fact that no one apparently has ever added it up. But the total is estimated to run to more than \$100 million—possibly as high as \$130 million.

• **Biggest chunk**—Easily the largest of these projects is the Defense Department's *Vela*, the three-part program aimed at developing means of detecting and identifying nuclear explosions set off underground, under water and at very high altitudes.

Since *Vela's* inception in the fall of 1959, Congress has appropriated for it a total of \$151.1 million. The bulk of this has been handled by ARPA, the rest by the AEC.

*Vela* is considered to be typical of the larger projects that the Arms Control Agency will undertake. However, because *Vela* is at a rather advanced stage, it is not generally expected to be transferred.

The Arms Control Agency is expected to award contracts for R&D projects directly to industry and private institutions, assign them to various government agencies or conduct some of them within the agency itself.

• **Organization**—William C. Foster, the industrialist and veteran government official whom President Kennedy named agency director immediately after signing the Arms Control Act, has made no decisions so far on how he will organize his staff. But the agency is expected to be organized generally along the same basic lines as the present Disarmament Administration that has been operating as part of the State Department.

The Disarmament Administration, which was established last fall, has three major divisions: A policy planning section, a political section and a projects and study section. It has operated under the direction of acting deputy director Adrian Fisher. Total staff: about 85.

Under the Arms Control Act, the entire Disarmament Administration automatically became the nucleus of the new agency, with Foster assuming the post of director.

Foster is expected to complete his organizational plans and lay down the agency's initial program within the next few weeks. To carry out the program, he is expected to increase his staff to about 250 over the next six months.

Most of the additions to the staff will be made in the projects and study section, or whatever division might take its place. Even today more than one-third of the agency is concentrated in this area.

However, under the old Disarmament Administration, the project and study section operated on an extremely limited budget. For FY '61, the entire Administration was authorized to spend only about \$400,000.

• **Unarmed negotiators**—It was precisely because of this meager approach to arms control R&D within the State Department—and the scattered and disorganized approach outside of it—that the Arms Control Act received powerful support from many in the Kennedy Administration and Congress.

The feeling in the Kennedy Administration now is that when Foster comes in with his list of projects there will be little trouble in getting the money. ■

# At IAC Stressing Peace—

## Reds Tell of Titov's 'Seasickness'

**Meeting attended by 600 from 27 nations largely ignores military implications of space exploration; other reports cover nuclear power, fuel cells, and materials**

**by William Beller**

SOVIET SCIENTISTS disclosed in Washington last week that Maj. Gherman Titov was mildly "seasick" most of the time during his historic 17½ orbits of the earth on Aug. 6.

This amplification of earlier reports that Titov had experienced "unpleasant sensations associated with his ear chamber" was virtually the only fresh information in papers presented by Russian delegates to the 12th International Astronautical Conference.

Despite reports of an impending new Soviet interplanetary space shot, the Russian visitors remained close-mouthed.

The Titov paper, by O. G. Gazenko and V. J. Yazdovsky of the USSR Academy of Sciences, said it appeared that the cosmonaut suffered nausea as a result of extreme weightlessness during most of the 25 hours he was in orbit.

Despite his discomfort, Titov kept a "sufficient level of working capacities at all times," the paper said.

As the flight went on, it reported, the unpleasant feeling worsened, particularly when the space man turned his head sharply. After he woke from his celebrated nap, the sensation eased steadily. But it did not disappear, the paper said, until the *Vostok* began to decelerate on re-entry.

"Thus," Gazenko and Yazdovsky wrote, "the sensation of some discomfort accompanied the considerable portion of the flight and resembled seasickness."

Their paper stressed that the flier was not seriously hampered by the condition of nausea, and that he was at all times able to carry out assignments.

Earlier official Soviet accounts told of Titov's difficulty with his inner ear while in a state of weightlessness, but did not elaborate.

The one other Soviet paper which came closest to new information was

a 16-page effort entitled, "Some Results of the Constant Geomagnetic Field Measurements Carried Out from Sputnik III over the Territory of the USSR," co-authored by five Soviet delegates.

• **Accent on Peace**—The unannounced but clear theme running through most of the Congress' papers and pervading conversations in the corridors was preservation of space for peaceful uses. Significantly, there were no technical papers on subjects even remotely connected with military uses of space—such as reconnaissance satellites, missile trajectories or space photography.

The keynote was struck during the opening ceremony when IAF president Leonid I. Sedov, member of the USSR Academy of Sciences, was asked if his country and the U.S. could get together on launching large payloads. His reply: "I think it will be possible in the future, not only between the Russians and Americans but with other countries as well."

Hugh Dryden, deputy administrator of the National Aeronautics and Space Administration, added, "Sedov and I have discussed this possibility many times. If the decision were ours alone, there would be no problem."

More than 600 delegates from 27 different countries attended the technical and sociological sessions.

Even from a legal point of view, outer space was regarded as reserved for peaceful uses. Professor Alex Meyer, director of the Institute of Air Law and Space Law of the University of Cologne, averted that "it is nearly unanimously recognized that outer space, by its nature, cannot be subject to any sovereignty and is to be considered as a free area like the high seas."

• **Cosmic cold war**—Taking a broader—and more frigid—view of the cold-war situation, and extending it to other planets, Harold D. Lasswell, Yale

University Law School and Graduate School, posed three eventualities should space explorers encounter extraterrestrial living forms:

—If explorers from a politically divided world meet living forms of a similar civilization in a similar predicament, extraterrestrial alliances will presumably be made—unless early contacts are multipartisan and gradual.

—If the newly discovered community is a dictatorship, it might not be eager to deal with its twin on earth as might swing toward the democratic bloc.

—If advanced forms of life have a superior civilization, they may treat earth with contempt and destructiveness.

In a technical paper, two Atomic Energy Commission scientists pointed out that nuclear electric propulsion would require extremely large amounts of electric power generated by machines having long reliable life and light weight. Specific weights in the 10-20 lb./hp. range and lower will be needed to explore the solar system. Lt. Col. G. L. Anderson and Cdr. D. L. Jarrell predicted that "In our time, these can be achieved only by high-temperature Rankine-cycle or thermionic systems."

The *SNAP-8* nuclear power system will have either a 30-kw or a 60-kw electrical output at a specific weight in the 50-to-70-lb./kw. range. Jarrell said that the initial ground tests of this system are planned for 1962.

Giving a status report on the Army's fuel-cell work, Ernst M. Cohn of the Army Research Office said that it was largely one of basic and applied research rather than development. He complained that this was caused in part by the fact that some early private government-sponsored development had to be delayed or discontinued when it became obvious that many chemical and material problems were still awaiting solutions.

Cohn admitted that several advanced missiles and rockets, October 9, 1961



been made in fuel-cell technology. Listed among others:

—The concept of using a solid membrane instead of a liquid electrolyte—brought closer to reality when General Electric showed a 200-watt unit that works on hydrogen and air with cationic membranes as electrolyte.

—The year's most sensationally treated fuel-cell announcement—the chemical fuel cell. Cohn said that while this concept is still in its initial stages and relatively few organizations are now pursuing it, the research already appears to be branching out into three distinct directions:

1) Attempts to imitate biological processes.

2) Possible *in vitro* use of biological materials as catalysts.

3) Use of primitive forms of life to decompose organic material and obtain fluid fuels suitable for use in fuel cells.

The problem of what materials to use in space, and where conventional materials fail, was reviewed by L. D. Jaffe and J. B. Rittenhouse of the Jet Propulsion Laboratory. They reported that studies show that cadmium and zinc platings will be lost through sublimation in space vacuum at those temperatures apt to be met in service. Metals such as aluminum and semiconductors such as germanium and silicon will not be appreciably affected.

They said that the vacuum behavior of high polymers must be treated in a different fashion because the large polymer molecules break down into volatile fragments.

Jaffe and Rittenhouse also brought out that: (1) friction and lubrication present a serious problem in the design of moving parts for space applications; (2) effects of solar ultraviolet radiation in space differ somewhat from those on the earth's surface because of the absence of oxygen—polymers are more apt to undergo cross-linking and accompanying hardening rather than fragmentation and softening; and (3) the surfaces of organic materials and glasses can be very seriously damaged in the radiation belts.

An interesting description of the moon's surface emerged from some lunar eclipse observations analyzed by Jan E. Gibson, U.S. Naval Research Laboratory. He said they seemed to indicate the topmost layer of the average lunar surface has thermal and electrical properties that might apply to a loose granular substance like dust or sand. Underlying this top layer is a depth of perhaps a half centimeter is a substratum having higher electric conductivity—somewhat like that of the heavier terrestrial soils. The deep subsurface seems to resemble rock. ❧

missiles and rockets, October 9, 1961

# Vice President Briefed At Ames and Edwards AFB

by Richard van Osten

LOS ANGELES — Problems facing *Apollo* designers were laid out for Vice President Lyndon B. Johnson by NASA's Ames Research Center scientists and engineers last week.

The Vice President was told that midcourse guidance by pilot input to a computer-type system will be required to place the vehicle within a six-mile initial point envelope in order to set up the desired lunar trajectory. Present calculations indicate that the average miss distance for a lunar target point landing is not likely to exceed two miles, with the human-corrected guidance concept.

The re-entry corridor for *Apollo* earth return at about 25,000 mph is a bit broader—40 miles between the upper limit, where air density is insufficient to permit proper deceleration, and lower limits where the air is too dense. The equivalent entry corridor for the *Mercury* capsule is eight miles deep.

At re-entry, the *Apollo* vehicle will generate about two times as much heat energy as *Mercury*. Calculated heat is about 30,000 B.T.U. per pound of vehicle weight. *Apollo* will be subject to both convective and radiative heating. An ablation-type shield will probably do the job, Ames scientists told the Vice President.

• “Moonstones”—Radiative heat is difficult to simulate, but Ames is having considerable success with a reflected carbon arc system and very small models. Dr. Dean Chapman showed some small tektites, or “moon marbles”—glass-like materials found in Australia. He said much could be learned about the heat requirements for *Apollo* from the tiny “stones,” believed to be from the moon, by scientific study of their character and temperatures to which they were subjected.

They are not the same as meteorites, Chapman said.

At the Ames space physics section, Johnson heard a brief outline of work in ion acceleration. The section is working on studies of the erosive effect of ions on surface coatings of materials, and is developing a solar radio emission receiver.

Ames also developed the low-energy proton analyzer on *Explorer XII* which, according to Dr. Alfred J. Eggers, Jr., is so oriented at the present time that the proton analyzer is faced away from the sun and is recording only background noise. It will eventually turn around and pick up the sun. Data obtained will be vital in determining when

conditions are undesirable for space missions due to solar flares.

Time prevented a complete briefing on Ames work, but the Vice President expressed extreme interest in the work in progress. He was accompanied by Rep. George Miller (D-Calif.), newly appointed chairman of the House Science and Astronautics Committee.

• Look at X-15—Flying to Edwards AFB later in the day, Johnson heard a briefing on the X-15 program and other NASA projects at the site.

The basic X-15 program is moving into its final stages. A 200,000-ft. altitude attempt is scheduled for this week, and a 4000-mph speed run will be attempted in about two weeks.

There will be more testing of the reaction controls, which have not been put into full use yet because of the relatively low altitudes of X-15 operations. An advanced control system is being installed in one X-15 and will be flown in about two weeks.

Other programs planned for the X-15, in addition to advanced controls development, include structural research, celestial photography and other space sciences. Highest temperature recorded on X-15 flights to date is 1050°F at a point on the lower fuselage.

Work is also under way at Edwards on the *Dyna-Soar* escape system for ground abort of a mission. NASA Pilot Neil Armstrong demonstrated the approach with the NASA A5D by making a low pass at about 1000 ft., pulling up to a vertical position and cutting power, rolling out level and landing power-off on the nearby runway.

The A5D closely simulates some general characteristics of the *Dyna-Soar* vehicle.

NASA personnel also commented on the Rogallo Wing concept of booster recovery, pointing out that a one-quarter-scale *Mercury* capsule has been recovered from 10,000 ft. with a development model.

The Vice President also visited Jet Propulsion Laboratory and Vandenberg AFB.

This was the first of Johnson's “listen and learn” trips, as he calls them. He is looking for problem areas in an attempt to determine if everything that should and could be done is being accomplished in the space programs.

The only problem he noted after his first-day tour was NASA's apparent difficulty in retaining personnel who move into industry for higher pay. He offered no immediate solution. ❧

# U.S. Set To Press Rendezvous Approach

*Lunar planning also calls for continuing development of Nova booster, in case direct flight is necessary*

by Hal Taylor

THE KENNEDY Administration is expected to announce in the near future a decision to push "orbital rendezvous" as a main U.S. avenue to achieve a manned lunar landing.

Development of a large *Nova* launch vehicle—prime booster for a direct flight to the moon—will also continue. If rendezvous proves to be feasible, *Nova* development will be considerably slowed or perhaps even dropped. A final decision will not be made for a year.

NASA Administrator James E. Webb said last week that "we will probably use the rendezvous concept." He estimated that if it works it could cut as much as two years off the timetable for a manned U.S. lunar landing.

Informed sources also report that the joint NASA-DOD committee set up to make recommendations on future U.S. space programs fully supports rendezvous and will recommend its development to President Kennedy.

Dr. Hugh L. Dryden, deputy administrator of the space agency, said in an interview that the new impetus for the rendezvous program will begin with a NASA program which will attempt to mate a *Mercury* capsule to an orbiting *Agena B* launch vehicle. The experimental program in rendezvous will begin shortly, he said.

The early experiments, Dryden explained, are intended to determine whether the basis for the rendezvous concept of space flight is sound—that is, can two space vehicles be joined together while orbiting in space.

• Bigger booster backed — Dr.

Dryden also said that support for four-F-1-engine version of the *Saturn* as a booster for possible future rendezvous flights in the moon program "he also stepped up."

The support for a larger booster than the currently planned *Saturn C-1*, with two F-1 engines, stems, he said, from the logistics requirements of the rendezvous operation. The C-3 would require several launches to complete the rendezvous mission.

A majority of the joint NASA-DOD committee also favors a larger booster than the *Saturn C-3*, and leans toward the four-F-1 engine configuration.

The new support for rendezvous is based on two considerations:

1. Less reliable launch vehicle could be used to put the materials for a manned lunar landing attempt in orbit; more reliable vehicles could be used to put the astronauts into orbit where the rendezvous could take place. This means that when the U.S. is ready for the lunar shot, the comparative new *Saturn* with two or four F-1 engines could be used to place the materials into orbit. The *Saturn C-1*, with eight H-1 engines—which by then would have three or four years of testing—could put the astronauts into orbit.

2. Rendezvous would cost about one-third less than a program utilizing direct flight to the moon with the multimillion-lb.-thrust *Nova* booster. An NASA official has estimated that it will cost some \$6 billion to develop the large *Nova* booster, including launch facilities. The cost per launch with the *Nova* is set at \$100 million—or \$10 billion for 100 launches. A total of \$16 billion is seen for the whole program.

The costs of rendezvous are estimated at: \$1 billion to develop the rendezvous technique; \$1 billion to bring the *Saturn* vehicle to operational level and build launch facilities; \$9 billion for 100 launches. Total: \$11 billion.

• Alternatives—The types of rendezvous under consideration include:

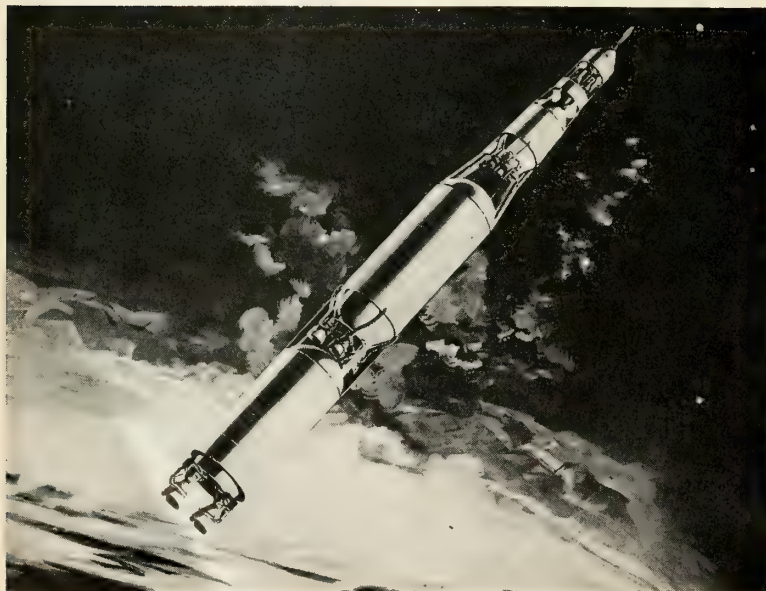
- 300-mile orbit, with two vehicles put into that orbit and an attempt made to join them.

- Send one vehicle to a 300-mile orbit and another to 150-mile orbit. The vehicle at the lower altitude would then fire again and be launched to the higher altitude, where it would couple onto the other vehicle.

- Send a man on a direct flight to the moon; then send another vehicle to the moon which he would use to return.

- While a large spacecraft orbits the moon, another smaller one would break off for the flight to and return from the lunar surface.

A good bet for a possible manned moon shot from the rendezvous concept is the 300-mile earth-orbit position.



NASA CONCEPT of the *Saturn C-3* with two F-1 engines in flight. Support for four-F-1-engine version is growing, and there is a good chance it will replace the C-3.



# NASA Revising Patent Law Proposals

HEATED INDUSTRY opposition forcing NASA to revise its proposed patent licensing regulations.

Gerald D. O'Brien, NASA's top patent official, admits that the size of the industry opposition was unexpected.

Industry representatives and patent lawyers attending recent public hearings were unanimous in their opposition to all regulations which would give the space agency the right to charge a fee for the use of NASA-owned patents—and also give firms exclusive use of such patents, in certain situations.

O'Brien also admits industry opposition will force some revision in the regulations. But, he says, "it is still too early to tell to what degree, or whether any major sections will be dropped."

The NASA official said it would be at least six months before a report is prepared on the public hearings, and some time after that before recommendations are made to NASA Administrator James E. Webb.

Meanwhile, there were these other developments in the government patent fight which has raged for the last two years:

—The National Space Council—the President's space advisory group—announced it is drawing up a uniform patent policy to cover inventions stemming from developmental work on communications satellites.

—Hopes for legislation to set up a government-wide patent policy have been revised slightly by promises of further action during the next session. Sen. John L. McClellan (D-Ark.), chairman of the Patent Subcommittee of the Senate Judiciary Committee, said at the current session ended that such legislation will be enacted next year. The House Space Committee also announced it will hold more hearings in December on legislation which would give NASA greater leeway in waiving the right to patent ownership.

• **Precedents lacking**—Most of the current controversy, both in Congress and the executive branch, stems from NASA's unique position in the "patent scheme of things." Only the AEC has a more stringent patent setup.

Under the National Space Act, the agency has the right of ownership to any patents accruing from inventions made by contractors in the performance

of research and development contracts.

If the contractor requests it, the space agency can waive its right of ownership. Title to the patent then goes to the contracting firm.

If no request is made or if the request is refused, ownership is retained by NASA.

Such NASA-owned patents have been piling up and the space agency, on July 15, proposed licensing regulations to put them to use:

—If the invention was developed by a NASA R&D contractor, the space agency could grant him a royalty-free, non-exclusive, non-transferable, and revocable license.

—Any other firm could get the same license to use the patent, but a fee would have to be paid to NASA for its use.

—If a firm could prove it needed protection from competition while putting a patent into commercial production, NASA could grant an exclusive right to use a patent on which the firm would have to pay a royalty.

• **United attack**—Industry opposition at the agency's public hearings was vociferous and unanimous.

Industry representatives included Charles L. Shelton, Aerospace Industries Association; A. L. Bain, National Security Industrial Association; Joseph Grey Jackson, American Bar Association Patent Section; K. S. Wyman, Allis-Chalmers Manufacturing Co.; Elmer Gorn, Electronic Industries Association; and T. M. Ferrill, National Association of Manufacturers.

Their opposition was based on three major points:

—NASA should not charge royalties for the use of government-owned patents.

—The cost of administering the licensing program would exceed fees obtained through the royalty system.

—There is some question as to whether executive agencies have authority under the Constitution to enforce a patent-licensing system or to give exclusive rights to a government-owned patent.

While the licensing regulations received most of the industry fire, the space agency's unique "patent ownership" rights also were attacked. U.S. industry would like that section of the

space act changed to bring it more in line with Department of Defense patent policy. In dealing with that department, the R&D contractor has the option to take out a patent on any invention. If he does not, DOD then can take ownership. The military agency also permits anyone to use a DOD patent without obtaining a license.

Shelton charged that "NASA patent ownership rights substantially reduce any incentive a company might have to perform research and development for the space agency."

• **Congress to dispose**—NASA this year did not take a position on legislation before the House Space Committee which would have changed its ownership rights to reflect the DOD system.

NASA said it was waiting for a government-wide patent policy to be formulated. Shelton charged that NASA's failure to take a position on the legislation stemmed from a feeling that its current ownership rights should not be repealed because it is not encountering as much difficulty in getting contractors as it anticipated.

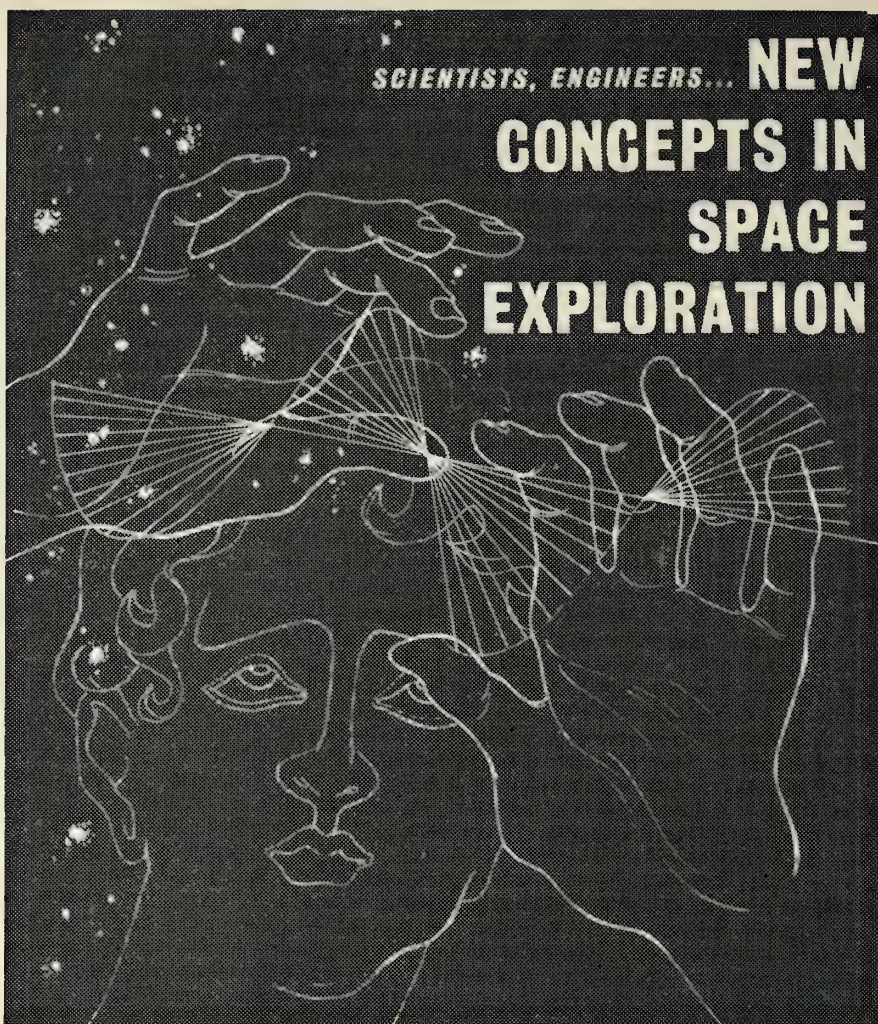
A settlement of NASA's patent dilemma probably will depend upon the passage of legislation establishing a government-wide policy. While Sen. McClellan has promised to push such legislation in the next session of Congress, a rough road lies ahead.

Differing bills have been introduced in the Senate. One would give to the government the ownership rights on all patents arising from R&D contracts. Others would give most ownership rights to industry, permitting the government to take title in a few areas.

Although Congress has asked executive agencies to come up with recommendations for a government-wide policy, none has been forthcoming. A committee in the Commerce Department which was set up to do the job held only one meeting about two months ago.

• **Council passes**—Some officials have expressed the hope that the space council's formulation of a patent policy on communication satellites can serve as a guide for over-all government policy. This is dispelled by council officials, who assert that their only job is to clear up the communication satellite controversy. #





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# Technical Countdown

## ADVANCED MATERIALS

### Soviets Looking into High-Energy Forming

An explosive-type ram impact machine, designed by the Zhukov Aviation Institute, is being used to study the plastic behavior of metals. One recommendation flowing from this original research is that explosive-forming installations should be developed in the USSR. The maximum amount of deformation in hot upsetting was investigated for carbon and alloy steels, titanium alloys, aluminum alloys and "... hard-form heat-resistance alloys."

### Silicon Nitride Space Coating

Air Force researchers are using thin films of silicon nitride to protect components from temperatures up to 3000°F. The coatings are non-conductive at high temperatures. In one instance, a condenser functioned perfectly after remaining for 400 hours at 932°F. The film is capable of preventing metallic oxidation at much higher temperatures.

## LIFE SUPPORT

### Radiation Studies Use 'Plastinauts'

The AF's Special Weapons Center is performance-testing three man-size "plastinauts" as a unique research instrument for the study of the biological effects of space radiation on man. The artificial human figures—designed to fly in any space vehicle which can carry a man—are made of a plastic which absorbs radiation in much the same way human tissue does. In fact, this plastic "flesh" reportedly has the same atomic make-up as the human body.

## SUPPORT EQUIPMENT

### Titan II Gets Propellant Transfer Units

Propellant Transfer Control Units—designed to deliver peroxide 50 or nitrogen tetroxide from storage tanks or tanks to the *Titan II* first and second stages—are being delivered by Hamilton Standard, a division of United Aircraft Corp., to The Martin Co. for use in the missile R&D program. The 12,000-lb. GSE units are completely self-contained and require only 440v, 60 cps power for a transfer capacity of 61 or 190 gpm at pressures over 100 psig.

### Mobile Cranes Ease Base Construction

Fragile and very costly pressure vessels for dual storage at the 12 *Atlas* sites throughout the country are now being moved more safely and economically by rubber-tired cranes. Equipped with solid-support outriggers operated from the cab by hydraulic power, the cranes—designed and manufactured by the Thew Shovel Co.—are capable of speeds up to 35 mph.

### Garrett Extends GSE Line

Product line extensions into the storage, transportation and pumping of cryogenic fluids for GSE applications are at the works at Garrett's AiResearch Mfg. Division. J. Conrill will manage the new operation. No site has been announced. Products will include cryogenic recharger vehicles, storage tankers, vaporizers, high-pressure pumps, couplings and samplers.

## ELECTRONICS

### Research Leaders Polled by DOD

Communications and command control systems rate highest priority in current research by the electronics industry. This is contrary to the widespread opinion that electronic-component reliability studies top the list. The conclusion is based on opinions of 49 industrial, academic and government electronics authorities polled by the Defense Department to determine most significant areas of current electronics research. Two top items of emphasis in the components field are solid-state and laser research.

### SD-5 Guidance Tested

The Army's new *SD-5* high-performance drone successfully completed its 13th flight last week, using an all-inertial guidance system for the first time. The Mach 0.7 reconnaissance jet is undergoing final development for the Signal Corps by Fairchild Stratost Corp. Minneapolis-Honeywell developed the inertial system. Flown over the Drone Test Range between Yuma and Fort Huachuca, Ariz., for almost two hours, its photographic system also was tested successfully for the first time. In its final form, the drone will be capable of transmitting all observed data to ground, either periodically or upon ground command.

### Package Cooling Studied by Army

Placing auxiliary thermoelectric cooling units in the walls of electronic packages can result in a significant increase in the size limits of the packages cooled by thermal conduction, according to a report recently released by the Army. The study of methods of cooling densely packaged electronics was based on a comparison of three types of cooling: simple conduction, thermoelectric (Peltier) effect, and a combination of the two. Findings indicated that the package structure can cool large units by thermal conduction through the structure members, with commensurate increases in package sizes and volumetric heat-release rates.

### Pacific Mercury Tracking Bats .667

Two of the three Project *Mercury* Pacific area tracking stations reported contact with the recent *MA-4* (orbited capsule with robot passenger) launch. PMR ground stations at Canton Island and Pt. Arguello, Calif., recorded telemetry transmissions from the capsule for over 7 and 4 minutes, respectively. The newly operational \$7-million installation at Kokee, Hawaii, missed the capsule because the vehicle flight path was too far south. Kokee did serve, however, as a communications station in world-wide *Mercury* net.

### Zeus Carries Dual-Destruct System

*Nike-Zeus*' automatic destruct system, an Army spokesman revealed last week, begins operation 5 seconds after launch and remains in operation for 11 sec. The safety system used in the recent *Zeus* test launch from Pacific Missile Range was programmed by an IBM-709 computer using inputs from a *Zeus* Missile Tracking Radar (MTR), a cosine tracking radar (COTAR), and an FPS-16 tracking radar. The system complements a manual ground-command destruct system controlled by the Range safety officer.

# Mercury Reaction Controls Revealed

**Bell-developed 'piloting' system described—  
company working on bipropellants for advanced vehicles**

**by John F. Judge**

BUFFALO, N.Y.—Details of the Mercury reaction control system—the astronaut's "piloting" apparatus—have been disclosed by Textron's Bell Aero-systems Co.

The system, developed by Bell under contract to McDonnell Aircraft Corp., governs all capsule orientation while in space. It can be either automatic or under the direct control of the astronaut.

Bell experts have already gone far beyond the Mercury monopropellant tank system. Research and development in bipropellants for more advanced space vehicles is in high gear at the firm.

The experience gained during the Mercury system development will contribute a great deal toward any second-generation reaction control system.

Bell reaction controls are also employed in *Centaur*. The company is in the running as a major producer of secondary propulsion systems to be used for vehicle orientation and attitude control, as well as ullage and separation devices.

• **Flexible system**—The capsule reaction control is a pressure-fed system incorporating right-angle-firing thrust chambers. Regulated helium pressure on the bladder-type monopropellant tank supplies concentrated  $H_2O_2$  to the catalyst beds, where rapid decomposition occurs.

The system is broken down into two subsystems, which can operate separately or together. There is an electrically controlled automatic subsystem and a manual subsystem capable of hand or electrical operation.

Two thrust modes in the automatic subsystem handle pitch, yaw and roll attitude. High thrust delivers a nominal 24 lbs. in the pitch and yaw attitudes, and a nominal 6 lbs. in the roll attitude. The low-thrust mode consists of chambers delivering a nominal 1-lb. thrust in the three attitudes.

The manual subsystem provides vehicle control in the high-thrust mode when electrically operated (rate stabilization mode). Variable thrust of 4 to 24 lbs. in pitch and yaw, and 1 to 6 lbs. in roll, is provided when the subsystem is under manual control.

Operating principles are essentially the same for both subsystems. A 2250-psig helium source pressure is reduced to 480-485 psig through a regulator and applied to the subsystem's 9711 Silastic bladder, expelling peroxide from the toroidal tank into the propellant feed system.

The propellant decomposes on contact with the catalyst bed, generating steam and free  $O_2$  to produce thrust. Direction of flow through the manual throttle valves, or the solenoid-operated valves in the manual system, is controlled by a manually operated selector valve.

• **Chamber components**—The thrust chamber assemblies include:

—Propellant inlet valves—the unit which checks or controls the propellant flow to the decomposition chambers. The automatic system's inlet valves controlling high and low torque pitch and yaw control are coaxial flow, solenoid-operated, on-off valves.

The high and low torque roll control unit is a dual-thrust chamber assembly with 6- and 1-lb. components on a common mounting flange. Each has its own solenoid-operated on-off inlet valve.

Manual pitch and yaw involves a 24-lb. thrust unit with a spring-loaded check valve. This is used in conjunction with a manually operated throttling valve in the proportional control mode, or a solenoid on-off valve in the rate stabilization mode.

The manual roll control is again a spring-loaded check valve used in conjunction with a manually operating throttling valve in the proportional modes or a solenoid on-off valve in the

rate stabilization mode.

—A heat-barrier tube which feeds the propellant from the inlet valve to the decomposition chamber. The small-diameter, thin-walled tube thermally insulates the inlet valve from the heat generated as a result of decomposition, keeping the valve and the upstream propellant at a tolerable temperature during the duty cycle.

—A trimming orifice, located between the heat barrier outlet and the decomposition chamber, compensates for random variations of the overall pressure drop through the assembly. This insures rated thrust output at a rated propellant feed pressure.

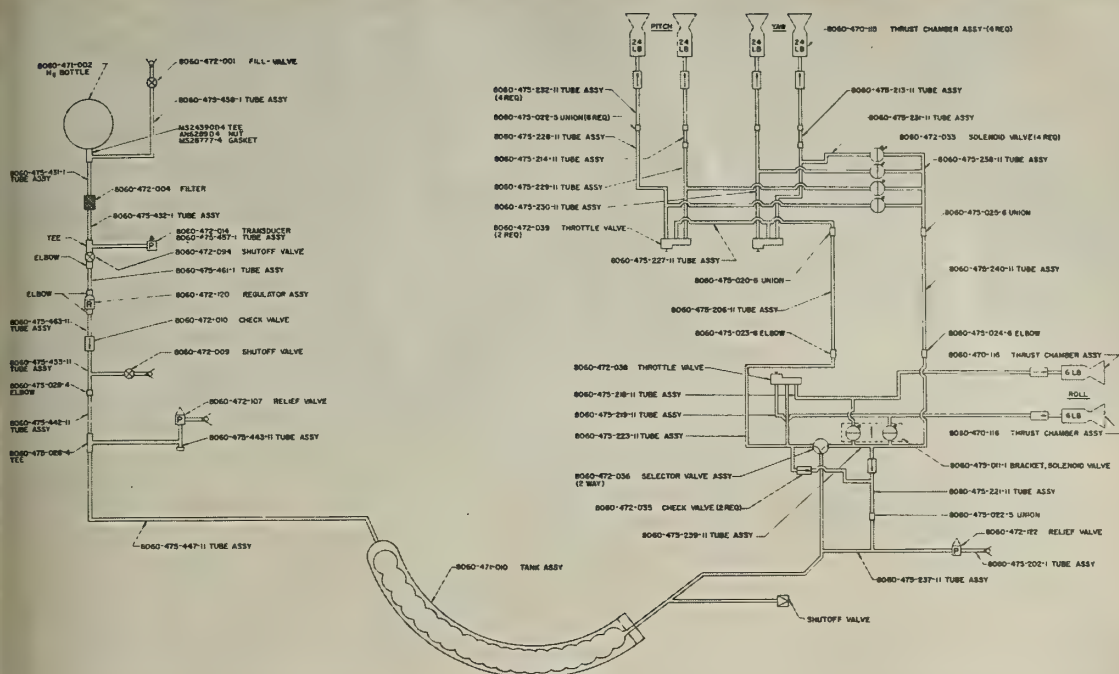
—The decomposition chamber houses the catalyst bed and contains the high-temperature decomposition products. The bed assembly consists of nickel wire-mesh discs plated with a silver alloy. These are stacked into thin-walled, stainless-steel retainer cups four to six in each chamber.

The upper lip of each cup, under axial load, provides a seal on the chamber wall, preventing propellant by-pass. The propellant is forced by inlet pressure into intimate contact with the large catalytic screen surface. Peroxide breakdown is triggered by an exchange of free electrons in the silver crystal lattice with the  $H_2O_2$  molecules, and then sustained by the thermal energy release of the exothermic decomposition reaction.

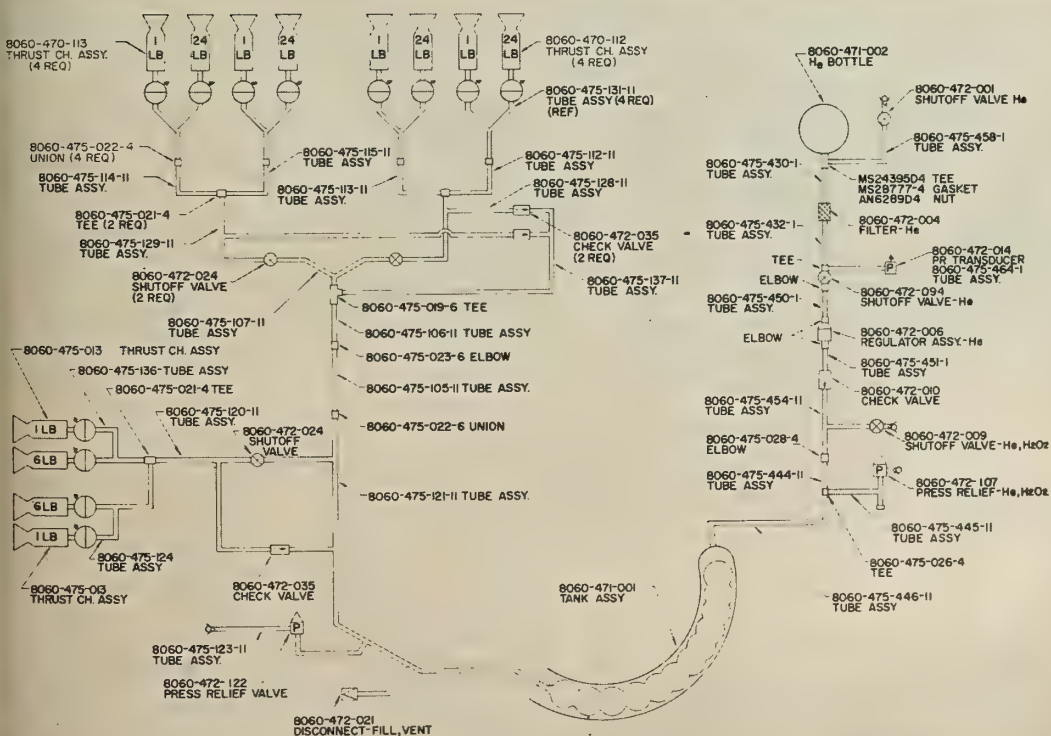
All of the peroxide is ultimately decomposed to an oxygen-superheated water mixture which exits through the nozzle.

The Mercury system is completely engineered for the particular job at hand. Bell engineers have found that off-the-shelf items seldom fit into such a system without modification. The Mercury system has revealed the problem areas that might be encountered in any future system.



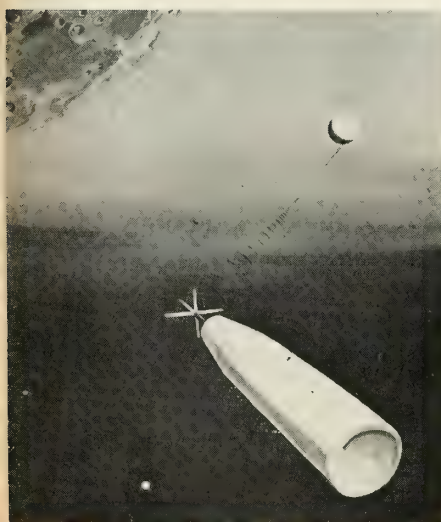


Manual Reaction Control System



Automatic Reaction Control System

# Air Force Satellites To Measure Interference



ARTIST'S conception of the Armour-designed interference-measuring satellite.

by Charles D. LaFond

A SERIES of electromagnetic interference-measuring satellites will be placed in orbit by the Air Force beginning late in 1962.

*Blue Scout* (HETS 109A) solid-fueled launch vehicles will be used to locate the 300-lb. spin-stabilized space packages in orbits at altitudes from 100 to 1000 miles.

Aim of the program is to determine the amplitude and spectrum characteristics of man-made radio interference that will be encountered by electronic systems operating in high-altitude aerospace vehicles. To assure that completely reliable navigation and communication equipment is available for future manned satellites and space vehicles, it is essential to know the frequency distributions and power densities at various altitudes.

The problem to date has been to determine the parameters and develop a practical automatic spectrum-analyzer system for use in an unmanned satellite that will accomplish the task.

All of the initial studies and breadboard designs have been performed by Armour Research Foundation (ARF) of the Illinois Institute of Technology in Chicago.

Sponsor of the program is the Communications and Electronic Department, Aeronautical Systems Div., AFSC, at Wright-Patterson AFB, Ohio.

• **Project status**—Two contracts have been awarded to ARF. The first, for \$144,000, was started in May, 1959, to determine the high-altitude interference parameters, to develop measurement techniques, and to design and build a breadboard prototype system.

Initially, measuring equipments were considered for use in space up to 1000 miles altitude over the frequency range of 75 kc to 75 gc (kmc). Use of both satellites and balloons was considered.

As a result of the early studies, it was determined that the range above 100 miles be explored, that a spin-stabilized satellite be used, and that selected radio frequencies be explored.

AF design requirements set a maximum of 2 cu. ft. volume and 100 lbs. weight for the instrumentation. These limits excluded power supply, command and telemetering equipment.

The complete instrumentation canister size was fixed at 300 lbs. total weight and a 3-ft. diameter to fit the lift and size capability of a *Blue Scout*.

The first contract was concluded in September, 1960; a second, for \$429,384, was awarded to ARF last August.

The new project will concentrate on microwave frequencies encountered at orbital altitudes, and will consist of two main tasks:

—To study instrumentation techniques and later build breadboard equip-

ment to measure electromagnetic interference at selected frequencies over the range of 1.7-17 gc.

—To study and provide recommendations covering methods for measuring r-f interference over the ranges of 17-35 gc and 35-80 gc.

Selected ranges to be covered by the ARF breadboard system are 1.7-2.3 gc, 4.0-6.0 gc, 8.0-10 gc, and 10-17 gc. The system will be designed to provide automatic frequency scanning and automatic amplitude control in an unmanned orbital test vehicle.

This portion of the spectrum requires increased emphasis, according to the Air Force, because of the trend toward increased use of the higher frequency bands for communications and other electronics systems. Also, these frequencies cover the whole radar range from L-band upward.

The influence of such high-power stations as those employed in BMEWS (Ballistic Missile Early Warning System) certainly will warrant study.

A third contract, to build the actual satellite hardware for studying the lower frequencies, will be awarded, the Air Force says, in the next few months. How many systems will be built has not been announced; however, it is known that only one satellite will be used for the lower-frequency study.

For studying the microwave frequencies, several satellites probably will be employed. It is possible, said one AF spokesman, that many more satellites will be used for selected frequencies at the upper end of the spectrum.

The Air Force has been trying to schedule the first launch within the first half of next year, but it appears now that the earliest possible date will be late in '62 or early '63.

• **Prototype hardware**—In its first study of the whole problem, ARF scientists considered five principal interference parameters as a function of orbital vehicle spatial position and time of measurement:

- Directions of signal arrival.
- Polarizations.
- Signal amplitudes.
- Frequencies.
- Types of signals or modulations.

The first was determined to be impractical for several reasons. Determination of direction would require a highly directional antenna—that is, one responsive to a hemispherical zone below the horizon. Also such a system would require broad-band coverage and rapid identification of signal direction.

Further, two or more signals present in the bandpass of the receiving equipment would result in a composite signal. Finally, directions of incoming signals might be altered considerably due to refractions, reflections, and scattering

missiles and rockets, October 9, 1961



ing over the propagation path.

The second parameter was found equally impractical. Signal polarization cannot be measured properly without establishing direction of arrival. Vehicle size-weight limitations and the problem of composite signals are handicaps.

As for identification of signal modulation, detection would require monitoring durations compatible with the modulation bandwidths. The result, ARF believes, would require a sacrifice in collecting rates for amplitude and frequency data. It was decided, then, that modulation characteristics would be obtained only when there might be no significant decrease in spectrum data collection rates.

Thus, the final parameters deemed essential for measurement are frequency and amplitude level, along with spatial position and time.

The final system evolved was composed of a program computer for system control and digital data analysis and readout, five receivers—four octave-coverage receivers, an information storage unit, and an antenna system.

Three receivers were designed to span the frequency octaves of 4-8 mc, 8-16 mc, and 16-32 mc by means of a stepped-frequency and i-f gain procedure using voltage-tunable inductors (creductors). An electronically swept, third superheterodyne receiver was built to cover the 120-180 mc range. Finally, an alternate-reception unit was designed for receiving two fixed microwave frequencies at 1010 and 2200mc.

An overall amplitude measurement range of 90 db was achieved.

Data readout is in digital form and magnetic tape storage is employed for periodic telemetering of collected information to ground stations.

Each receiver covers its octave range in a series of 128 discrete steps, each step 1 msec. long. A seven-digit binary code associated with each step is used for frequency identification.

After frequency stepping at one gain level, receiver gain is stepped sequentially 6 db at a time for 16 different gain levels. This achieves spectral exploration of signal strength versus frequency. A four-digit code is generated for designation of signal levels.

Following each step, video is observed at the receiver detector output for about 0.9 msec. The presence or absence of a signal at the reference amplitude level is determined and a pulse is produced if the video exceeds reference gain level. These data are recorded while the next step is under observation. Thus, ARF says, about 95% of receiver sampling time is used for signal observation.

Following data recording from the first receiver, the programmer switches the antenna to the next receiver. Also, video sampler output of that receiver is connected to the recorder and plate power is applied to it.

For sequential transmission to ground, 13 telemetry subcarrier channels will be required for the observed data. ARF has suggested use of an

FM/FM multiplex system operating in the 216-235 mc band.

Antenna physical design limits required with use of *Blue Scout* were: 15 lbs. for the antenna and erection equipment; capability for containment in a 24-in. dia. cylindrical vehicle and within 1.5 cu. ft. total volume.

For the 4-32 mc range, an unfurlable log-periodic dipole array was designed as a part of the initial study.

For the higher range (100 mc to 4 gc), a non-planar unfurlable version of a log-conical spiral was selected.

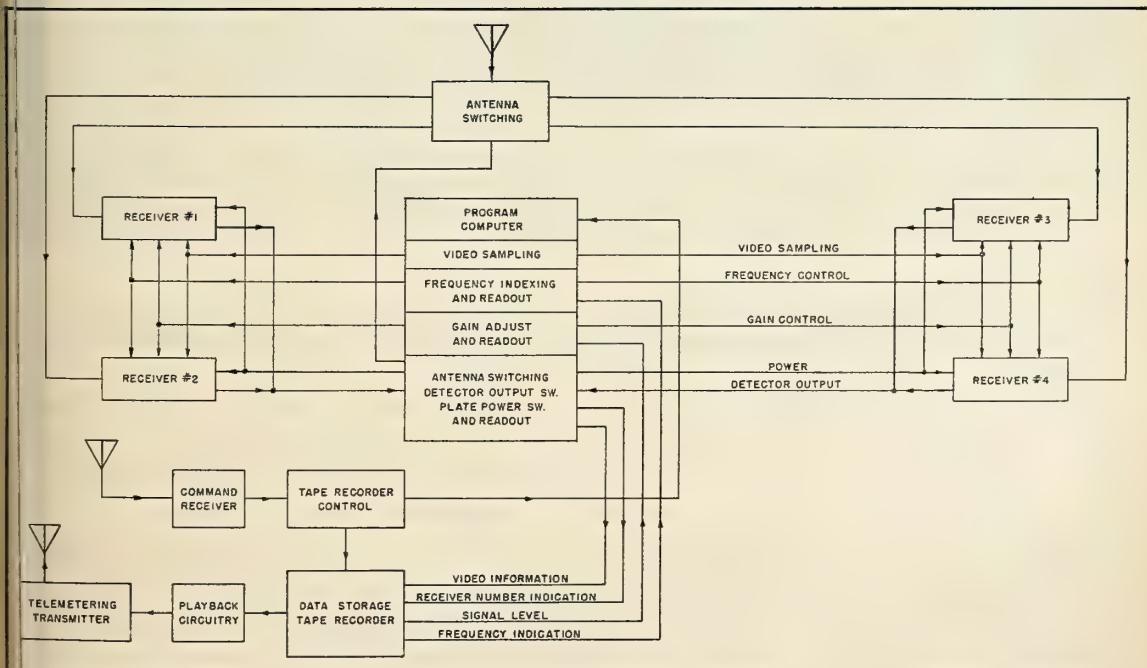
However, both of these can only be used with an advanced launch vehicle of the future.

For use with the *Blue Scout* system, a less efficient orthogonal array of three small electric dipoles was suggested, as a compromise.

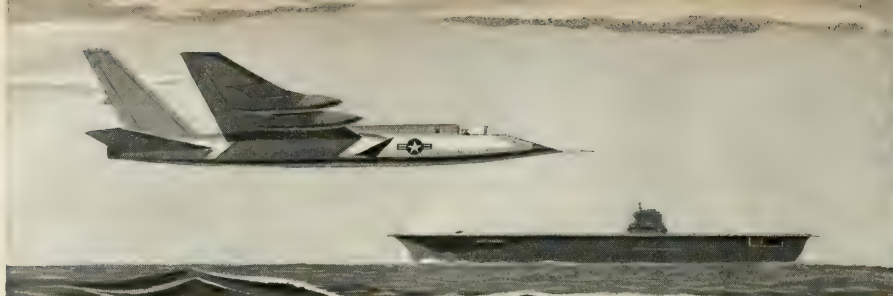
This would be an omnidirectional antenna, insensitive to vehicle spin.

Dipoles are 29.5 in. long overall and the satellite casing itself forms a part of the array. To permit furling, dipole elements would be made of stressed aluminum ribbon. The exact configuration for this antenna remains to be determined.

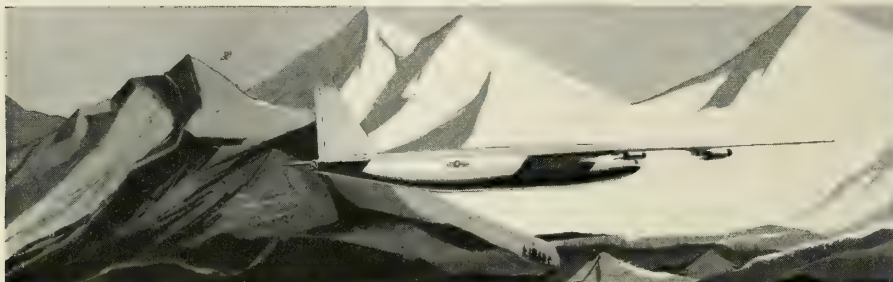
For the future, ARF believes the prototype instrumentation proves feasibility of the program. Actual satellite hardware, it asserts, can be miniaturized readily, but it believes that only two receivers might be used initially for the 100-180 mc and 275-400 mc range. With these frequency ranges, size-weight limitations can be met easily. \*\*



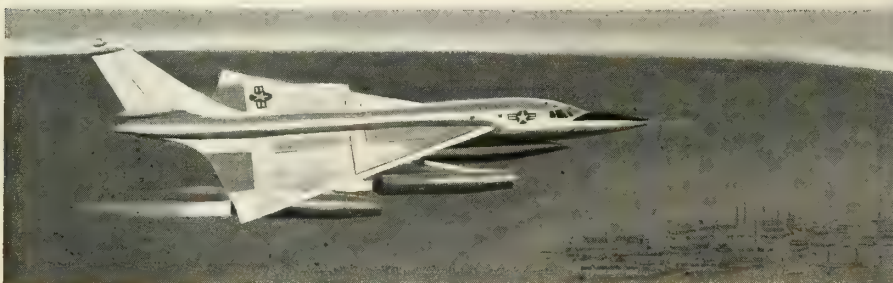
BLOCK DIAGRAM of proposed interference measuring system showing sequential operation of four receiving channels.



**NAVIGATION** — Raytheon in 1958 developed a highly sophisticated Doppler Navigation System for the U.S. Navy's A3J. This system was the forerunner of an advanced Raytheon Doppler System now operational in the U.S. Air Force's B-58.



**TERRAIN AVOIDANCE** — Raytheon designed and is producing the U.S. Air Force's only operational low-altitude target acquisition radar. It is currently installed on the Strategic Air Command's B-52 intercontinental bomber.



**BOMB-NAVIGATION SYSTEMS** — Raytheon developed and produced an integrated radar-radome for the high performance B-58. With the Raytheon Doppler System (the most accurate in use today, despite severe environmental conditions) these radars are vital elements of the Hustler's bomb-navigation system.



## ***Raytheon brings proven capability***

Experience and achievements give ample proof of Raytheon's ability to develop and produce operational equipments that would enable high-performance aircraft to carry out the deep penetration-low altitude attack mission: ■ Raytheon Doppler navigation radars for the A3J and B-58 ■ Raytheon terrain

avoidance radars for the B-52 ■ Raytheon bomb-navigation radars for the B-58 ■ Raytheon low altitude guidance systems for interceptor missiles.

Add to these Raytheon's selection as prime contractor-systems manager for the U.S. Army's and Marine Corps' HAWK and the





## the low altitude attack mission

U. S. Navy's SPARROW III missile systems; as producer of the 2nd generation Polaris' advanced guidance system; and as systems manager of the ARPAT Terminal Defense System program.

One of the world's largest scientific-industrial organizations, Raytheon can create the

required technology and manage every phase of a complex defense or space system — from early study and design through development, production and field support of operational systems and equipment.

*Missile and Space Division, Bedford, Massachusetts.*

RAYTHEON COMPANY

MISSILE AND SPACE DIVISION

RAYTHEON

## Guardsmen Fire Army

THE *HONEST JOHN* is still the mainstay tactical surface-to-surface missile of the U.S. Army.

The 12-mile-range missile represents the principal tactical nuclear punch of U.S. troops on the Central Front in Europe.

Except for *Lacrosse*, *Honest John* is the only short-range nuclear missile available in any quantity. It is the weapon on which the Army can be expected to put the most reliance in a tactical nuclear war on the ground.

*Honest Johns* not only are in the hands of U.S. troops in Europe, but are also deployed with other NATO units



ARTILLERYMAN of 1st Howitzer Btn. sites rocket prior to firing.

TACTICAL MISSILE gets final checkout before launch at A. P. Hill.





# Honest John Battlefield Work Horse

including the Italians and West Germans.

U.S. troops have had considerable experience in operating with *Honest Johns* in maneuvers both overseas and in the United States since the missile became operational in 1953.

National Guard troops began training with *Honest Johns* this summer. The 28th Infantry Division in July became the first Guard unit to launch an *Honest John*.

The launching—depicted on these pages—was conducted by the 1st Howitzer Battalion of the 28th's 108th Artillery at Camp A.P. Hill, Va.



**LEFT:** *Missile on transporter-launcher drawn by jeep awaits firing. Equipment not shown includes standard five-ton crane for manhandling missile onto its launcher, wind-set for gauging weather conditions.*

**RIGHT:** *Last-minute check of wiring is conducted by the Pennsylvania Guardsmen.*

**BELOW:** *Honest John takes off successfully in first firing by National Guard troops.*





## Superoxide

**MSA Research says system  
can be readily produced for  
Apollo; cites simplicity,  
lightness, other benefits**

**by Heather M. Davis**

**LEFT:** Space backpack contains superoxide system which completely controls suit, removes odors, trace contaminants, bacteria, CO<sub>2</sub> and water vapor, and supplies oxygen.

**RIGHT:** Mouse has existed breathing only oxygen supplied by an open superoxide bed in his sealed "cabin." Passive system tends to overproduce oxygen; active system (see flow diagram, p. 10) oxygen production can be regulated.

**FAR RIGHT:** Machine man (consisting of a man in a sealed chamber) is undergoing a test at MSAR's sea chamber. Equipment designed by company can simulate breathing process of one or more men, provide data for design without tying up company personnel.



# Developed to Supply Astronauts' Air

CALLERY, PA.—Just a few pounds of highly active yellow granules may one day furnish all of an astronaut's oxygen.

Two compounds, both superoxides, show great promise as reliable sources of fresh, comfortably dry air free of contamination. A Pennsylvania company has developed their use to such a degree that company spokesmen say they are ready to engineer and produce systems for an *Apollo*-type flight.

The chemicals are the extremely active oxides of potassium and sodium ( $\text{KO}_2$  and  $\text{Na}_2\text{O}_2$ ). MSA Research Corporation, wholly-owned subsidiary of Mine Safety Appliances, is working under contract to the National Aeronautics and Space Administration and the Navy on their use for space. The NASA award came after more than a decade of company-funded studies.

MSAR lists these advantages of a superoxide system over conventional high-pressure or liquid oxygen systems:

—**"All-in-one" simplicity**—One canister of either potassium or sodium superoxide will accomplish all the things which must be done to purify

used air: it removes  $\text{CO}_2$  (lithium hydroxide is used in the *Mercury* system, molecular sieves also have been used); it removes some water; it removes trace contaminants including indole and skatole (digestive gases), for which activated charcoal generally is suggested; it removes bacteria, and it produces oxygen.

—**Lightness**—A supply of one of the superoxides accomplishing all these things would amount to about 4 lbs. of chemical per man day. Heavy containers like those used for storing LOX or high-pressure oxygen are not required.

—**Volume**—The amount of space required to store a supply of superoxide is less than that required for lithium hydroxide needed for the same amount of time. Little equipment is needed. The chemical may be stored and used in a thin wall canister. The other major components are a blower and heat exchanger.

—**No high pressure**—The system operates at ambient pressure. There is no risk of failure in high-pressure fittings.

—**Reliability**—Minimum moving parts and lack of complicated valve systems make the system very reliable. The chemical will always react for its given life.

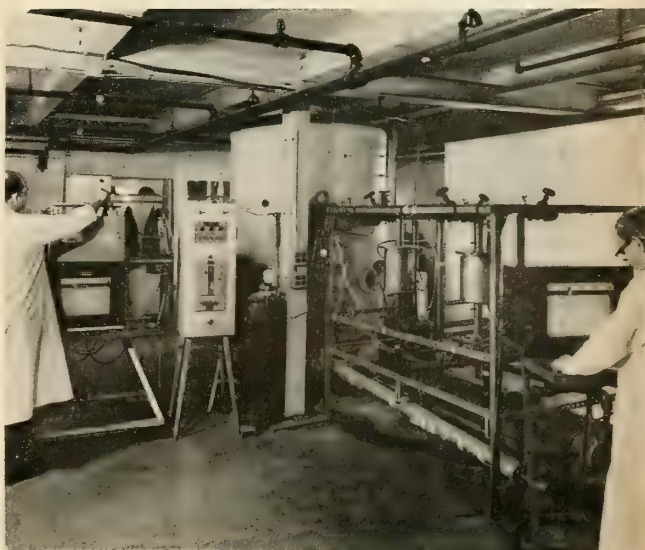
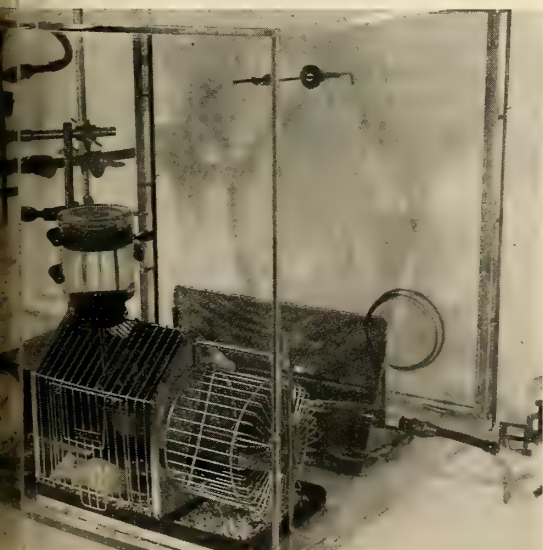
—**Engineering flexibility**—The canisters can be made into any shape and can be designed to fit otherwise useless corners or spaces.

—**Bacteria removal**—The chemicals appear to be very effective in removing many respiratory viruses and bacteria. This obviously has special advantages for a crew of several men.

The system got a good test last year at the Navy's Air Crew Equipment Laboratory in Philadelphia. Six men spent a period of eight days in a sealed chamber breathing oxygen supplied by a potassium superoxide system.

In the chamber, a blower circulated air through a cooling apparatus, then through the superoxide canister. Total oxygen released was from 80 to 95%. The canisters removed part of the water vapor, and all odors, trace contaminants.

An ingenious machine at MSAR has run hundreds of tests simulating the







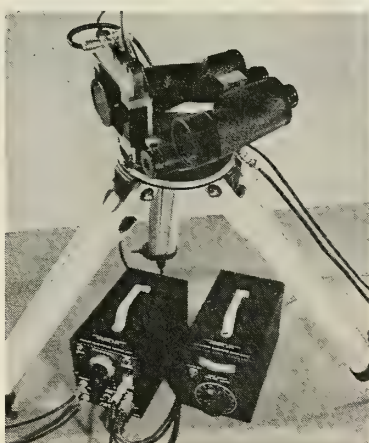
# Shutter to Prevent Nuclear Blinding

OPTICAL EQUIPMENT operators try to avoid nuclear flash blindness through a device being perfected by Electro-Optical Systems, Inc.

The experimental model is designed to protect personnel using high-powered binoculars and telescopes for reconnaissance or field bombardment spotting. The mechanism can effectively and automatically close out the light from a nuclear flash in one ten-thousandth of a second.

Anti-flash measures are a problem in aircraft and shipboard operations as well as in tactical battlefield situations; studies are under way to extend the principle to these applications.

The protection device consists of a stressed plate shutter placed in front of the objective end of optical instruments. The shutter assembly includes an ordinary piece of glass mounted between a pair of rigid beams. Stacks of piezo-



MODEL of shutter mounted on binoculars.

electric drivers are placed at either end of the beams.

Voltage applied to these driver

stacks causes expansion or contraction depending on the voltage polarity. Strain induced in the glass causes temporary double refraction, which changes the state of polarization of a light beam passing through the shutter plate.

If the shutter plate is placed between a pair of crossed or parallel polarizers and a modulation voltage is applied to the driver stacks, the light beam passing through will be modulated from a full-open to a full-close. The shutter is a mechanical analog of the kerr cell.

In addition to the rapid closure time, the eye protection device will be capable of opening as quickly as possible after the initial flash. This is to make possible visual inspection of a battlefield immediately after a nuclear explosion.

The unit can be adapted to field use with battery power. The development is being sponsored by the Frankfort Arsenal, Army Ordnance Corps. \*\*

## BAR-X-SEALS EVERYTHING

AT TEMPERATURES FROM -400°F TO +1500°F!

ANY FLUID—GAS—FUELS—WATER—LIQUID METALS—CRYOGENIC FLUIDS—CORROSIVE FLUIDS  
ANY SYSTEM—HYDRAULIC—PNEUMATIC—VACUUM—CRYOGENIC—NUCLEAR

|                                                      |                                             |                                                                                                                                                                                                                                                                                                                                                                                 |                                                                   |                                           |                                              |
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| <p>IT SEALS</p> <p>IT GAS SERVOS</p>                 | <p>IT SEALS</p> <p>VACUUM SYSTEMS</p>       | <p>SEAL HERE</p> <p>LOAD HERE</p> <p>LOADING RING</p> <p>SEAL HERE</p> <p><b>DUAL-SEAL REDUNDANT DESIGN</b><br/>DYNAMIC &amp; STATIC APPLICATIONS</p>                                                                                                                                                                                                                           | <p>BAR-X-SIZES:<br/>1/2" TO 3" STANDARD<br/>3" TO 12" SPECIAL</p> | <p>IT SEALS</p> <p>SPACE ENVIRONMENTS</p> | <p>IT SEALS</p> <p>INFINITE STORAGE LIFE</p> |
| <p>IT SEALS</p> <p>PUMPS</p>                         | <p>IT SEALS</p> <p>HYDRAULIC ACTUATORS</p>  | <p><b>NO CATASTROPHIC FAILURES</b><br/><b>INFINITE STORAGE LIFE</b><br/><b>UNPRECEDENTED SERVICE LIFE</b></p> <p>Eliminates critical downtime ■ Very high and very low pressure<br/>■ Easy, foolproof installation (not a mechanism) ■ All-metal—non-contaminating ■ Stable, symmetrical design</p> <p>WRITE TODAY FOR THE FULL STORY! SALES ENGINEERS IN PRINCIPAL CITIES.</p> |                                                                   |                                           |                                              |
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# Army R&D Dollars Now Go to Industry

**Von Braun-less ABMA shifts emphasis to outside development, but still sees bright future**

by James Trainor

HUNTSVILLE, ALA.—A major shift in emphasis from in-house development of missile systems to reliance on outside contractors is the most significant result of the transfer of the "Von Braun team" from the Army Ballistic Missile Agency to NASA.

Some 90% of the money appropriated for the Army Ordnance Missile Command now is going to industry, according to Maj. Gen. August Schonberg, AOMC commander.

More than 54,000 businesses are sharing in the contracts.

The transfer of more than 4000 people and \$100 million of facilities and equipment, Army officials point out, forced ABMA to re-examine both the relationship of the agency to the contractor and the function of its research and development division. This rethinking has brought about changes in or-

ganization, contractor philosophy and in-house capability.

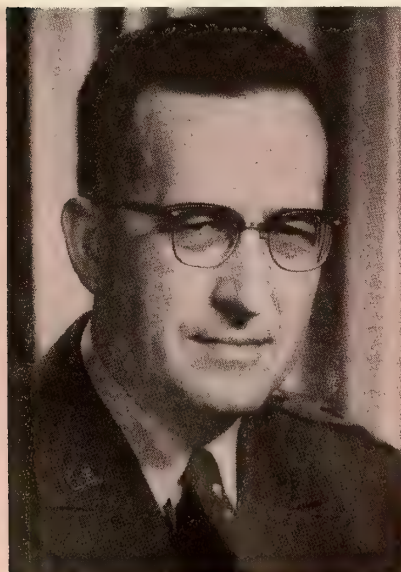
• **What goes on now**—When the transfer was effected on July 1, 1960, ABMA was left with only three programs—*Jupiter*, *Redstone* and *Pershing*—and only one of these, *Pershing*, could really be said to be under development. However, since the agency was to develop "systems whose trajectories are predetermined, essentially ballistic in nature," seven systems with their project personnel were transferred from the Army Rocket and Guided Missile Agency to ABMA on August 1, 1960. These seven were: *Corporal*, *Sergeant*, *Honest John*, *Little John*, *LAW* (*Light Anti-Tank Weapon*), *Missile A* and *Missile B*.

However, of the 10 now under ABMA's wing all but *Pershing*, *Missile A* and *Missile B* are in production or

actually in the field. This means that the industrial and field service divisions of the agency are coming more to the fore. It is the responsibility of these divisions to provide the industrial, logistical and maintenance support for the systems in the field. Until the *Sergeant* becomes operational, none of the systems developed over the past years has been obsoleted—which means that the workload on these two divisions is constantly increasing.

• **Organizational changes**—To place greater emphasis on future Army requirements for missile systems and provide sound management for systems under development, Brig. Gen. Richard M. Hurst, ABMA Commander (in box), has made two important organizational changes.

First, he has established an Advanced Plans Division responsible for evaluating



## Scholarly Commander Steers Agency Through

BRIG. GEN. Richard M. Hurst, commander of the Army Ballistic Missile Agency, represents a sharp break with the flamboyant past of the Medaris era. Quiet, assuming Gen. Hurst, according to his associates, is a highly competent soldier-scholar who is interested in sound management and value engineering.

Coming to ABMA shortly before the transfer of the highly touted Von Braun team to NASA, he has overseen the dismantling of one agency and the rebuilding of "new" ABMA. However, as he pointed out in an interview with *MISSILES AND ROCKETS*, the job of building up the organization is still unfinished even now—fifteen months after the transfer.

• **Background and experience**—Although relatively unversed in the missile field prior to his assignment as commander of ABMA, Gen. Hurst, '52, has a long list of achievements both as an ordnance officer and as a student. Educated in the elementary and secondary schools of Indiana and South Dakota, he graduated from Purdue University in 1930 with a degree in Electrical Engineering. Later,



ating contractor proposals, keeping abreast of the state-of-the-art and recommending systems for development that would be beneficial to the Field Army or its elements in 1965-70.

Second, to improve management techniques and to take advantage of new techniques Hurst has established a Policy Planning Council which reports directly to him. This body—consisting of four highly qualified officers—studies the organization's present structure and recommends changes or the incorporation of new techniques that have proven successful in other programs. For example, PERT—highly successful in the Polaris program—is one of the many approaches to program management that have been studied by this group.

• **Contractor philosophy changes**—Under the Von Braun approach, contractors often found themselves with nothing to do in the development of an Army missile system. They were presented with an already designed and fabricated system and told to produce it—with some product improvement allowed. However advantageous this method may be, ABMA can no longer use it to build ballistic weapons for the simple reason that the agency does not possess the tremendous in-house capability in men and materials that such a system entails.

This does not mean, however, that ABMA intends to abrogate its responsibility for system development. One of the major tasks of Research and Development Operations—headed by Dr. Arthur Rudolph—will be to oversee the contractors' efforts and to provide technical guidance and supervision to industry.

## Major Revisions in Staff and Assignments . . .

Northwestern, he received two post-graduate degrees: Master of Business Administration and Doctor of Philosophy. Upon graduation from Purdue, he received a reserve commission in the Field Artillery. However, it was not until 1935 that he was called to active duty for three years. He returned to active duty in 1940 in the Ordnance Corps, and was integrated into the Regular Army in 1946.

During World War II he served in Ordnance positions at Fort Benjamin Harrison, Ind.; Fort Hayes, Ohio; and the Central Pacific area. After the war he was assigned to the Rainier Ordnance Depot and the Office of Chief of Ordnance in Washington. After completing the course at the Armed Forces Staff College, he served successively as Deputy Ordnance Officer for the Eighth Army in Korea, 1st. Commander, Ordnance Weapons Command, Commander of Watertown Arsenal, and Deputy Commander of the Ordnance Tank-Automotive Command.

• **Vocation and avocation**—One of those fortunate individuals who has been able to combine work with pleasure, Gen. Hurst admits that although he hasn't been able



*SERGEANT—here blasting off at White Sands—is one of 10 systems under ABMA.*

• **In-house capability changes**—These changes in emphasis are clearly evident in the organization and functions of Dr. Rudolph's department. Broken down into six labs (compared to ten in the old organization), the group is expected to have a maximum strength of little over 1000 engineers, scientists and administrative personnel. This compares to approximately 4500 before the transfer.

This cutback in personnel is attributed to the change in the contractor approach. It also enabled the Army to combine some of its labs in order to get maximum utilization of its resources.

The labs, in conjunction with project offices in the headquarters element of the R&D Operations, will provide the technical know-how to monitor

Army contracts. In addition, they will be called upon to project and apply the state of the art to advanced missile systems. The major burden for this advance planning, however, rests with one lab: Analysis and Advanced Design. It will develop the technical characteristics for new systems and work with a system until it becomes a funded project. At this point, A&AD Lab's interest in the program is transferred to a project office.

Research Lab—under Dr. Gerhard Reisig—is charged with providing the supporting research necessary to insure the uninterrupted development of a system. In the past, there have been instances in which programs have been delayed because, as one R&D man put it, "we didn't do our homework." It is Dr. Reisig's job to see that this doesn't happen in the future.

• **What of the future?**—The fielding of these 10 systems, however, does not mean the end of ABMA's R&D tasks. Under study are programs to develop a longer-range, more accurate *Pershing* for use by the field Army. At the other end of the spectrum, increased attention and emphasis are being placed on small rockets and missiles to provide both heavy and light antitank and assault weapons for battlefield use, and on meteorological rockets for use with tactical systems to provide up-to-date meteorological and climatological data to the firing unit. The development of Multi-System Test Equipment is also being examined in a joint effort with ARGMA.

Other areas of interest include: extremely low-cost frangible boosters which would provide safety to troops in

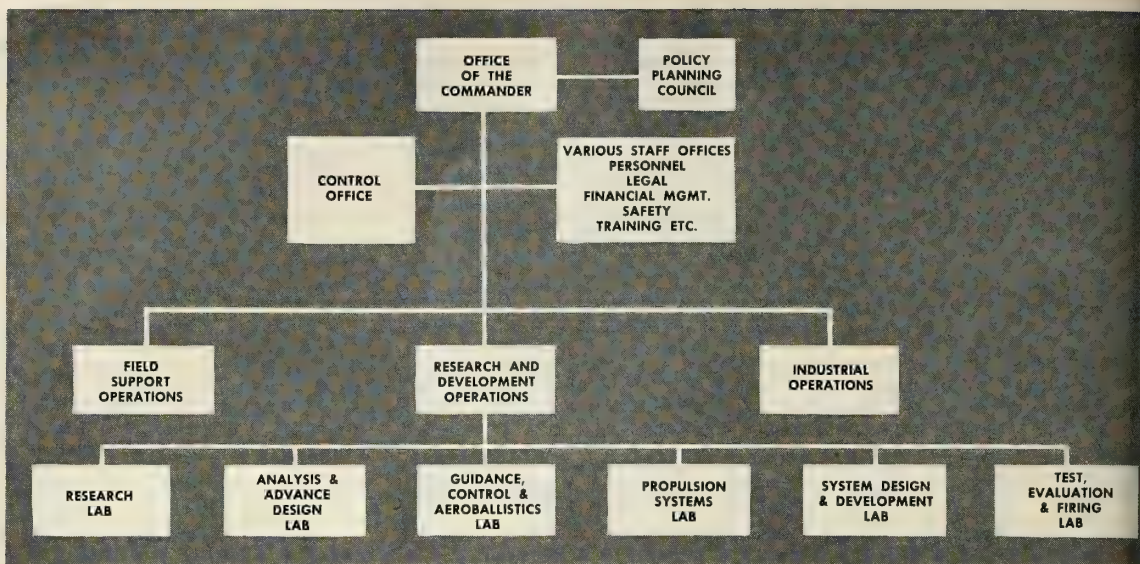
to play much tennis lately, his job gives him a chance to practice his main hobby: the study of management and the effective application of its principles. This predilection is clearly evident in the changes and re-orientation of the agency since General Hurst assumed command. Particularly, the emphasis on advance planning to insure ABMA's future and on value analysis is aimed at getting maximum possible mileage from the dollars filtered down to the agency.

Gen. Hurst is married and has two children: Nicholas, a cadet at the U.S. Military Academy, and Susan, a high school freshman.

Promoted to General in July, 1960, Gen. Hurst has won the respect of his subordinates by the manner in which he has kept the agency on course in spite of the NASA transfer and the addition of six new development programs. As one of them put it, it was like "coming out of the dugout without any warmup and finding yourself at bat with two strikes on you."

Neither the agency nor its Commander has struck out yet, he added.





Organizational Chart of Army Ballistic Missile Agency

front of the launch area; improved mobility with consideration being given to Goer and zero-ground-pressure vehicles; and the development of special armaments for conventional and unconventional warfare.

- **Inadequate facilities**—Perhaps the most discouraging aspect of the transfer is the inadequacy of the facilities that ABMA has occupied for the past year. Scattered over the length and breadth of Redstone Arsenal, the agency occupies some 36 buildings—ranging from an old munitions packing line to quonset huts and warehouses.

ABMA also shares its headquarters building with the Marshall Space Flight Center, which has not only the third floor of the building but also the complete fourth wing.

This impractical situation will be alleviated, however, by two upcoming construction projects. The first is a new, eight-story office building for the Marshall Center—scheduled to get under way this year. This will take some of the strain off of ABMA by returning to them the office space now occupied by NASA in the headquarters building.

The second construction project—just approved by Congress—provides for a \$4.75-million research and development facility. This building will eventually house elements of all the labs.

A static test stand has recently been completed and turned over to ABMA's Test, Evaluation and Firing Lab. Although the instrumentation is not completely finished, the first captive tests were run on the stand last month.

- **Continuing problems**—With the construction of new facilities many of ABMA's problems will be solved. However, there are two nagging difficulties

which have the agency worried. The first is the continued buildup of NASA and particularly the Marshall Center. Since the human resources in the Huntsville area are limited, and the past year has been to a degree frustrating due to the lack of facilities, ABMA officials are worried they will lose more of their best people to NASA.

According to one official, everyone of any value in the Army organization has at least one job offer from Marshall. He is worried that many of these people may be lost to the Army.

"They offer our people new ways to do new things," he explains, "while we offer them new ways to old things." Admittedly, NASA has a greater appeal for this reason.

The second problem is to get greater recognition of the importance of supporting research at higher levels of command and a greater creativity at lower echelons. Most people endorse supporting research, the argument runs, until it is time to spend money on it—then they are only interested in hardware. Since the store of basic knowledge is diminishing, it is more important than ever that adequate supporting research funds be allocated not only to ABMA but to other development agencies as well.

To effectively utilize these funds and to develop the ideas for future systems, ABMA is trying to find or develop creative engineers. As one official expressed it, if ABMA could get six really creative people, it could build up a brain trust which eventually would become so strong and respected that the people who determine Army requirements would buy the agency's recommendations more readily.

Fifteen months after the NASA transfer, ABMA is not so much reorganized as reoriented. The agency is still recovering from the loss of last year. However, with its attention directed exclusively to providing ballistic weapons to the Army, its chief spokesmen describe its future as bright.

## System Fills Agena Tanks With Near-Perfect Accuracy

A SPECIALIZED propellant transfer system for the Agena series of satellites is being installed at both Canaveral and Vandenberg AFB, Calif.

The 19-ft.-long units, developed by Lockheed Missiles and Space Company, Van Nuys, Calif., plant, are said to be capable of filling Agena's fuel storage tanks with an accuracy of 99.9% or better.

Two of the transfer systems are used with each vehicle to be fueled. Each system contains a 1300-gallon tank. One propellant weight tank contains inhibited red fuming nitric acid (IRFN) and the other unsymmetrical dimethylhydrazine (UDMH). Propellant is transferred in a "just right" amount slightly over 1200 gallons, flowing into the Agena at approximately 40°F at a rate of 40 gallons per minute.

Each system is equipped with self-automatic electrical and pneumatic systems for propellant transfer, plus safety features to minimize explosion and dangers. The valves, pneumatic electrical controls on the unit can be operated by one person, but during actual countdown procedures, all controls are handled remotely from the launch blockhouse.

missiles and rockets, October 9, 1964



# Huge 'Beetle' to Handle Nuclear Power

*"BEETLE" with cab in lowered position, shown in photo of GE model.*



A MAMMOTH 80-ton tracked vehicle, shielded for handling nuclear power and propulsion equipment, is under construction at General Electric's Cincinnati plant for the Air Force Systems Command.

Powered by a 525-hp gasoline engine, the vehicle—nicknamed the "Beetle"—will enable its operator to operate in close proximity to highly radioactive equipment. It is shielded against radiation by foot-thick lead. Its leaded glass windows are nearly two feet thick. This shielding will enable its use during tests of nuclear rockets to make adjustments with-

out stopping the tests.

The vehicle is equipped with two huge mechanical arms, a periscope, TV cameras, radiation measuring instruments and high-intensity lights.

The operator's cab can move up and down or rotate. It is equipped with two-way radio, a TV screen and air conditioning. Height of the cab is 25 ft. when raised, 10 ft. when lowered.

The "Beetle," measuring 19 ft. in length and 12½ ft. in width, has a top speed of 10 m.p.h. The robot mechanical arms, with a maximum reach of 18 ft., are sensitive enough to pick up an egg without breaking it and strong

enough to bend a steel bar.

After completion of construction at Cincinnati this winter, the AF Special Weapons Center will test the monster in cooperation with the Atomic Energy Commission at the Nevada Test Site. Its capability to move over various types of terrain and to manipulate different nuclear power and propulsion systems will be checked out in a program expected to last about six months.

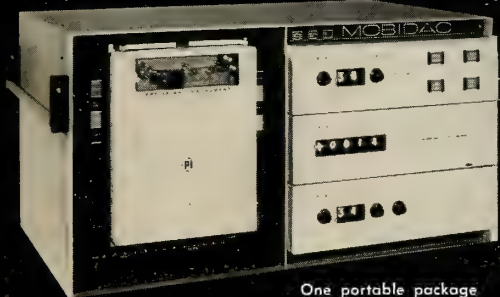
Subsequently, the Air Force expects to use the information for design of second-generation air-transportable handling vehicles for its nuclear power programs. \*\*

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Three-year gap? . . .

# Reds May Be Using Saturn-Class Boosters

Examination of known data  
and logical estimates of  
progress suggest thrust of  
about 1.5 million pounds

by Dandridge M. Cole

Consulting Astronautical Engineer  
Missile and Space Vehicle Dept.,  
General Electric Co.

THE CURRENT SERIES of Russian missile firings in the Pacific area indicates the Soviet Union may already have boosters in operation equivalent to the U.S. *Saturn*, which is scheduled for its initial test launching next week (see p. 9).

If true, this means the Soviets are as much as three years ahead of the U.S. in efforts to send a man to the moon.

The Soviet launchings of a new rocket of even greater size than the *Vostok* launcher raise anew the issue of the space booster gap and the attendant questions regarding the performance of Russian space launchers.

The question of orbital payload capability is reasonably clear, assuming that Russian announcements on payload masses have been accurate. These statements have been generally accepted as correct by U.S. experts and have been confirmed indirectly by photographs of rocket stages in orbit, the performance of the *Vostok* capsules and other evidence.

• **Thrust overestimated?**—The picture on rocket thrust, size, and configuration, however, is not so clear. While not as important as payload capability, the question of thrust, in particular, has been of continual interest and may be of some importance in assessing growth potential and future payload capability.

Although Russia has never disclosed the thrust of the *Vostok* launcher, it has frequently been stated as fact by U.S. publications that the thrust is 800,000 lbs. In spite of the wide use of this figure, however, there are several good reasons for questioning its accuracy.

Rocket experts in the West have maintained almost without exception, since the launching of the first *Sputnik* in 1957, that Russian rockets were larger, simpler, cruder, less efficient, but more reliable than their American counterparts. This view was neatly expressed by Herman Oberth in his famous statement that "the Russians were building alarm clocks while the Americans were building ladies wrist watches."

This view has not been seriously challenged. In fact, it still seems to be a highly reasonable belief consistent with all the known facts. It is not, however, consistent with the belief that the *Vostok* launcher had a thrust of 800,000 pounds and a takeoff mass of about 500,000 pounds!

• **Realistic gauge**—A useful measure of overall rocket mass efficiency is the gross-to-payload ratio—takeoff mass divided by payload mass. U.S. performance as measured by this parameter has increased rapidly since 1958.

The first *Explorer* in 1958 had a payload ratio of about 3000 and the first *Vanguard* about 7000. In *Van-*

*guard III*, this was improved to 450. With *Midas II*, U.S. performance improved to 70 and with future vehicles even better performance is expected. *Saturn C-1* should reach about 50 and the *C-2* was to have reached 25 (with high-energy upper stages).

The Russian rocket which carried 14,000 lbs. into orbit early this year would have a payload ratio of 37 at a gross mass of 500,000 pounds. This would be almost twice the mass efficiency of the best U.S. effort to date and better than any lox-kerosene rocket being developed in this country.

If these figures are true, then Russia must either be credited with a lead in propulsion techniques (high-energy chemicals) or a lead in structural design, or both, in addition to their acknowledged lead in size. Belief in this kind of Russian advantage is a little too much like the belief that they are 12 feet tall and does not seem reasonable. It would appear to be more likely that they have gained their booster lead by the simple and direct approach of building larger vehicles.

It can be assumed that the *Vostok* and the *Venus* probes used the same booster stages, but that the *Venus* probe used a three-stage configuration and the *Vostoks* two stages. This would be consistent with a desire for higher reliability in the manned vehicles and with the difference in payload.

• **Saturn already here?**—Also assuming that the payload ratio for the *Venus* probe was 70 or the same as the U.S. best to date, then the big Russian space booster has a gross mass of approximately one million pounds and thrust of perhaps 1.5 million pounds. In other words, Russia already has something equivalent to *Saturn* in operation.

This estimate is supported by the official Russian statement that the *Vostok* launcher had a takeoff horsepower of 20,000,000. If it is assumed that the propellants are kerosene and oxygen with an exhaust velocity of 8000 feet per second, then the takeoff thrust would be  $20 \times 550 \times 10^6$  divided by  $8 \times 10^3$ , which is equal to  $1.32 \times 10^6$ .

This figure is further supported by the official Russian statement that the *Vostok* launcher had six engines. Presumably these would be the large available proven and reliable engines. It has been known for more than 50 years that a group of captured German scientists designed a 220,000-lb.-thrust engine, the R-14, for a Russian IRB. Now, if six R-14 engines were clustered for the *Vostok* launcher, the total thrust would be  $1.32 \times 10^6$  lbs.

• **Step by step**—It is interesting to speculate as to the probable course of Russian rocket development in the past and its possible future direction. Some

missiles and rockets, October 9, 1958



estimates of the growth in thrust and gross mass are illustrated in Figure 1.

Russia captured V-2 production facilities in 1945 and began to produce these rockets in quantity with little loss in time. By 1950, with the help of captured German scientists, they had developed an improved short-range rocket with about 100,000 lbs. of thrust, and it is generally agreed that by 1955 they had an IRBM with 220,000 lbs. of thrust and weighing perhaps 150,000 lbs.

In May, 1958, Russia launched *Sputnik III* with a payload of 3000 lbs. If we assume a payload ratio of 100, the booster must have had a takeoff mass of about 300,000 lbs. If two R-14 engines were used, the thrust would have been 440,000 lbs. It may be that one of their short-range rockets was used as a second stage.

Now how did they make their next big step to the *Vostok* launcher? It was assumed earlier that the six engines used were R-14 engines. Thus, they could have constructed the first stage by clustering three of the *Sputnik III* booster stages—resulting in a booster of almost one-million-pounds takeoff mass.

The Russian rocket program has been impressive in at least two important respects, other than the rocket size. One is an apparent high degree of reliability. The other is the short development cycle of their new vehicles. Both

of these characteristics could be accounted for by assuming the development of standardized and routine procedures for clustering proven hardware with a minimum of modification during the clustering process. Some loss of performance would be accepted as preferable to modification, with its resulting loss of time and reliability.

• **Side by side**—Because of its consistency with this philosophy of clustering standardized tank-engine modules, the lateral staging method, suggested by the writer in 1951, might have been adopted by the Russians.

In lateral staging as opposed to tandem, stages are clustered side-by-side. All engines are ignited on the ground. When first-stage propellant tanks are empty, the first stage drops off while the second stage *continues* under power rather than starting at the time of staging as in the tandem method. By using all engines at takeoff, the maximum weight can be lifted from the earth for a given number of engines.

The propellant mass fraction of the lateral-staged rocket can be improved by using propellant from only the first stage tanks during first-stage burning and then switching to the second-stage tank for the sustainer phase. Thus, the main difference between the tandem and the lateral methods is that the second stage or sustainer engine has been borrowed during the boost phase to raise the booster thrust.

The advantage in propellant traction gained in using lateral staging might be converted into propellant tanks sufficiently strong to use pressure feed rather than pumps. This would decrease cost and development time and increase reliability.

Lateral staging might be the explanation for the large size of *Sputnik III* final stage which was photographed in orbit. This orbiting stage was estimated to be about 90 ft. long and 8 to 10 ft. in diameter. This is a little difficult to reconcile with tandem staging and more compatible with the lateral method.

• **Advancing by jumps**—And what comes after the *Vostok* launcher? Actually it is already here. Russia has stated that the rockets now being fired into the Pacific are larger and more powerful than the *Vostok* launcher. Since it is their custom to make substantial jumps rather than marginal improvements in booster capability, it seems probable that the new rocket will be larger by at least a factor of two.

This new booster might be constructed by extending the clustering method to twelve R-14's for a total thrust of approximately 3 million lbs. or by using new larger engines. Since the R-14 thrust could presumably be uprated to 300,000 lbs., the new booster could have a growth potential to about 3.6 million lbs.

(Continued on page 49)

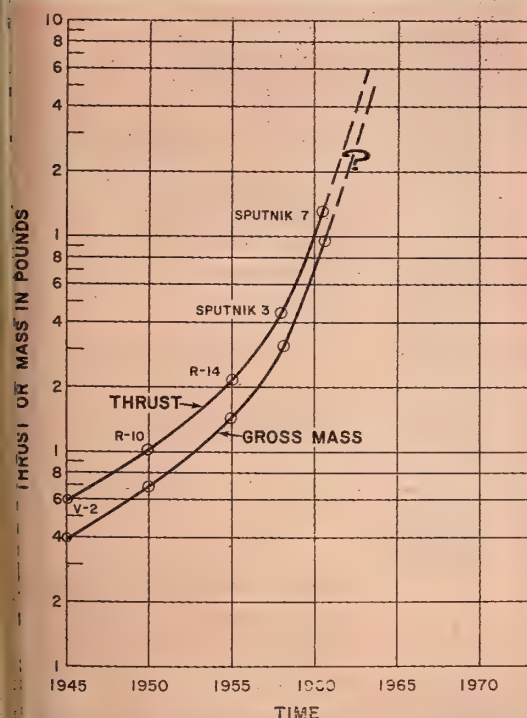


FIGURE 1—Growth of thrust and mass of Soviet boosters.

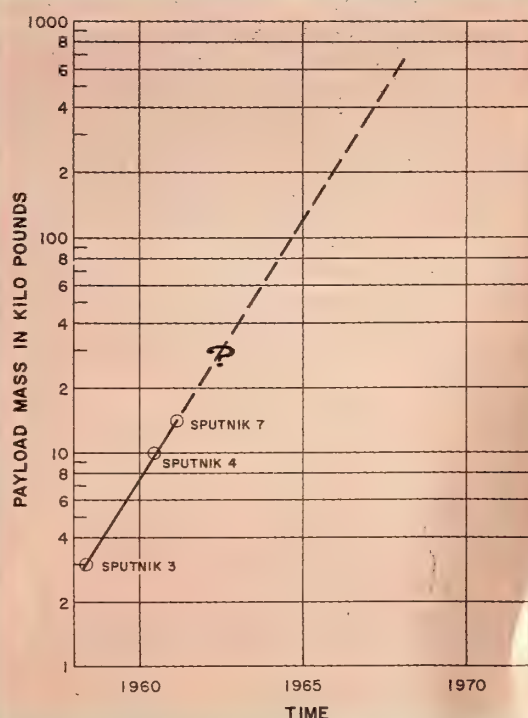
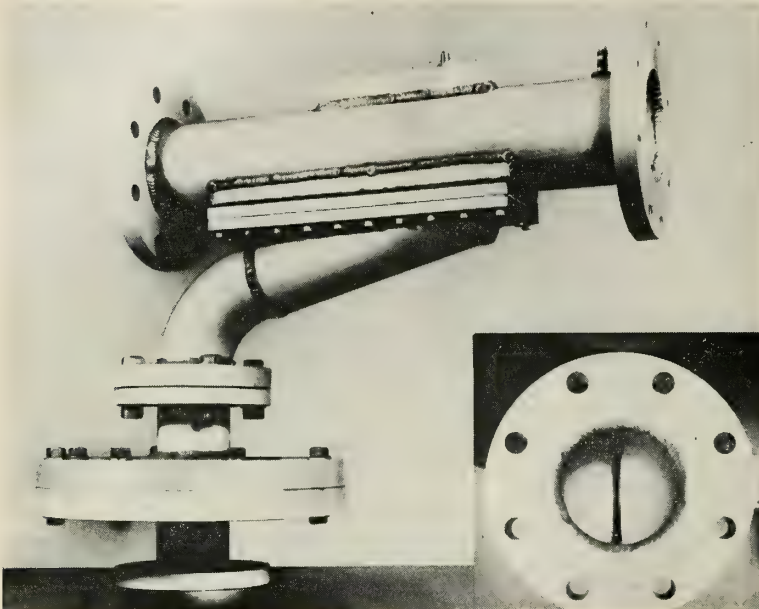


FIGURE 2—Maximum payload capability of Russian boosters.



## New Product of the Week:

### Flow Sampling Wedge

Wyle Laboratories has designed and developed a high-accuracy dynamic flow sampling wedge for use in ground support propellant loading systems.

Accuracies to within 2.5% in the prediction of main-stream contaminant levels, over extreme density variation ranges, are provided by the wedge.

The sampler is designed so that its unique high-accuracy performance extends to sampling of high-pressure flows. The flow-sampling wedge can be used with any liquid, gas, or combination, and under virtually any conditions of flow, temperature, and pressure.

The possibility of errors due to settling is eliminated by the collection of a "slice" specimen of fluid covering the full vertical cross-section of the stream.

Circle No. 225 on Subscriber Service Card

## Hi Voltage D-C Sources

Three precision d-c sources are available from Smith-Florence, Inc.

Offering accuracies of 0.25% of any output voltage dialed, the Model 120 provides 20 ma over the range of 500 to 2210 vdc, the Model 122, 20 ma from 0 to 3000 vdc, and the Model 123, 20 ma from 0 to 6000 vdc.

Only 3½-in. high, the Model 120 features in-line controls, regulated filament power, polarity reversal, modular construction, and removable rubber feet for rack or bench use. Models 122 and 123, mounted on 5¼-in. panels, feature handi-vider in-line controls, voltage and current metering, and reversible polarity. They are the only precision power supplies available that go down to zero voltage.

Other key specifications for the three

models: stability, 0.005% per hour; regulation vs. line change, 0.01% for  $\pm 0.10\%$  line; regulation vs. load, 0.01% for 20 ma change; and ripple of less than 5 mv rms at any output voltage and current in either polarity.

Circle No. 226 on Subscriber Service Card

## Balance/Calibration Unit

The Model BC411 isolated balance and calibration unit for strain gage instrumentation systems is being marketed by Computer Engineering Associates.

It has a plug-in printed circuit card that makes it possible to change the entire set of calibrations and dummy bridge resistors in less than 30 seconds. It can be used with 6-wire or 8-wire transducer cables, single- or double-shunt calibration, with calibration steps of both polarities. Each unit has a

double-level isolation in that both chassis and circuitry are fully isolated from the rack module and adjacent channels enabling use of the unit with isolated power supplies and amplifiers without compromising overall system performance.

Circle No. 227 on Subscriber Service Card

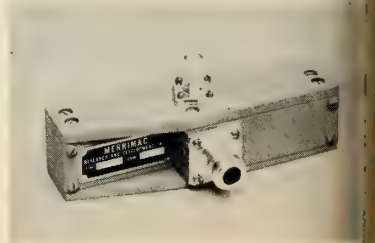
## High Power Diplexer

Rantec Corp. is marketing the FUU-401 Diplexer. This unit has been used to provide extremely high isolation between a high power transmitter and a receiver operating on the same antenna system. The unit was designed specifically for the 800-1000 mc band being used for satellite and deep space probes. 120db isolation between the transmitter and receiver is obtained with a receiver pass band loss of only 0.3db. The transmitter arm of the diplexer has an insertion loss of less than 0.1db. The pass band widths are approximately 20mc.

Circle No. 228 on Subscriber Service Card

## Variable Attenuator

Merrimac Research and Development, Inc. is marketing an electronically controlled, solid-state variable attenuator, Model AAE-1. The unit is sweepable over a minimum of 15 db of attenuation range over the 200 to 60



mc band, with flat attenuation vs. frequency characteristics. Initial loss under 2 db at the band edges and under 1 db at band center, and VSWR under 1.7:1 at band edges and under 1.4:1 at band center. Small (3.25 in. long from input to output), the attenuator requires only a few milliwatts of bias power.

Circle No. 229 on Subscriber Service Card

## Miniaturized Potentiometer

A miniaturized, precision multi-turn potentiometer, measuring only ¾-in. diameter and weighing just five grams is now available from General Controls Co.

Designated the PM305, the tiny, 1

missiles and rockets, October 9, 1970



turn potentiometer features a molded body, which contributes to its reliability in temperatures ranging up to 150°C. Rotation of the wire-wound pot is 360°, plus 20°, minus 0°, with an active coil length of 8-in. Torque is 0.5 oz./in. maximum.

Some of the electrical specifications: resistance range, 50 to 100,000 ohms; resistance tolerance  $\pm 0.3\%$ , with the best practical being  $\pm 0.1\%$ ; power rating one watt at 85°C (derated to 0 at 150°C).

Circle No. 230 on Subscriber Service Card

## Air-powered Transfer Pump

An air-powered transfer pump is now being offered by the Aero Equipment Corp. Called "Little Squirt," the pump is designed to eliminate time-consuming, inefficient hand pumping of fluids from drums to other containers at points of use.

The unit will pump up to 7 gal./min. free flow, and handles fluids up to 90 weight gear oil. The "Little Squirt" will transfer almost any kind of non-corrosive fluids, including oils, gear oils, water, kerosene, gasoline, anti-freeze, thinners and solvents. Delivery is instantly adjustable from zero to full flow, and operation is without hazard from explosion or sparks, because the pump is completely air powered, requiring as little as 15 psi, or on standard line pressures up to 150 psi.

Weighing only 2¼ lb. and measuring 16¾ in. x 11½ in., the pump is said to be the lightest, smallest reciprocating pump on the market, with a record of six million cycles in life test.

Circle No. 231 on Subscriber Service Card

## Voltage converters

A low-cost, compact line of precision d-c voltage-to-frequency converters is available from Pioneer Magnetics Inc. The Falcon-Magaverter line of voltage-to-frequency converters is completely solid-state, offering extreme reliability with minimum space and weight. The unit converts 0 to 5 volts (or more) d-c into a pulse or square wave output. This output frequency varies linearly with the d-c input signal from approximately zero cps to the pre-set full-scale frequency. Four standard models give full-scale out-put frequencies of 500 cps to 4000 cps.

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## Lakproof Hermetic Pumps

Buffalo Pumps has developed a line of centrifugal pumps, totally enclosed and hermetically sealed for use with toxic, inflammable or highly volatile fluids.

Simplified design includes a long-

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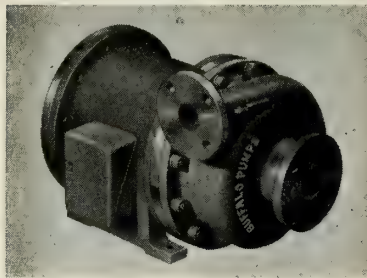
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life, self-adjusting bearing. Mechanical seals and stuffing boxes are eliminated. Positive protection is provided against leakage of expensive or noxious liquids. The line at present includes 13 sizes,



with discharges ranging from 1-in. to 5-in. Standard units are designed for 120 psig and temperatures of 40°F through 250°F. In the event of excess loads, automatic thermo-protectors imbedded in stator rotor windings prevents motor burn-out.

Circle No. 233 on Subscriber Service Card

## Microetch Varactor Diodes

The Special Products Operations, Lansdale Div., have developed Philco's line of microetch germanium varactor diodes designed as highly efficient harmonic generators. These units provide simultaneous operation at maximum frequency and maximum voltage.

The series, comprising types L-4110, L-4111, and L-4112, have very high cutoff frequency and greatly increased



capacitance variation, promoting unusual efficiency. The performance of these varactors as harmonic generator devices was continually monitored in Philco harmonic generator circuits.

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## Transfer System

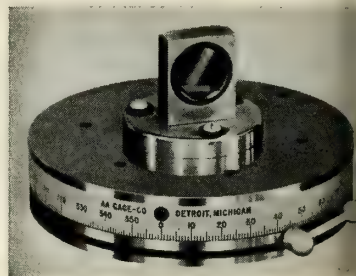
The electric Products Division of Vickers, Inc. has designed and developed an all static automatic transfer unit. This device, since it is all static, offers greater reliability together with fast response, low noise level and long

life. The present unit is capable of transferring from one 60 cps bus to another in a few milliseconds. This basic unit will be extended to perform the function of bus transfer switches per MIL S-17773-A except that switching will be accomplished statically and speed of transfer will be improved by an order of magnitude.

Circle No. 235 on Subscriber Service Card

## Angle Checker

By combining a plane mirror and miniature Ultradex indexing table, A. Gage Co. has developed the 360-side optic-mechanical polygon for checking or calibrating angles. This instrument is guaranteed accurate to 1/4 sec./arc total accumulated error, traceable to the



National Bureau of Standards.

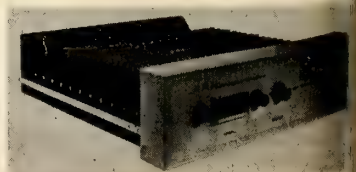
The base is made up of two plates each with 360 serrations, that are separated when the operating handle is depressed. The top plate can then be moved through any angle and lowered onto the bottom plate. Regardless of what degree of angle is being checked, all 360 serrations engage. This principle allows the serrations to seat uniformly so that the instrument maintains its accuracy through use.

Circle No. 236 on Subscriber Service Card

## Low-Level Multiplexer

Individual gain and zero adjustments for each channel are features of a low-level multiplexer recently announced by Systems Engineering Laboratories, Inc. The Model LL-1 Multiplexer accepts differential inputs directly from transducers at levels as low as  $\pm 5$  millivolts full scale and produces a commutated full-scale output of 10 volts.

The unit has an input impedance greater than 100,000 ohms and a com



missiles and rockets, October 9, 1964



non-mode rejection better than  $10^6$  to at 60 cycles with 120-ohm unbalanced input. The multiplexer is supplied with up to 48-channel capability, with sampling programs selectable from the front panel rotary switch.

Circle No. 237 on Subscriber Service Card

## Adjustable T.C. Resistor

A hermetically-sealed Temp-A-Just resistor with adjustable temperature coefficient is offered by Conrad-Carson Electronics, Inc. Model 7610 has a form gear lead screw adjustment of T.C. over a range of  $\pm 10$  PPM/ $^{\circ}$ C to 500 PPM/ $^{\circ}$ C. Standard fixed resistance values are 100 ohms, 200 ohms, 500 ohms, 750 ohms, 1k, 1.5k, 2k, 2.5k, 3k, 3.5k, 4k 4.5k 5k. Special resistance values and other T.C. spectrums will be made to order. The Temp-A-Just provides adjustable compensations for temperature-sensitive components or circuits.

Circle No. 238 on Subscriber Service Card

## Small Fission Counter

An extremely small fission counter with a flexible coaxial cable, Type WX-4706, is now available from Westinghouse Electric Corp. It is designed for thermal neutron fluxes up to  $10^8$  neutrons/cm $^2$ -sec., or  $10^8$  nv.

Measuring less than 1/4-in. in diameter and less than 3-in. long, the device has an integrally attached 6-ft. length of 1/8-in.-diameter coaxial cable. All metal parts of the WX-4706 are titanium to assure low activation. The insulation is high-purity, vacuum-sealed ceramic.

Thermal neutron sensitivity is  $10^{-3}$  cps/nv, with a minimum resistance of  $10^{12}$  ohms. Normal operating voltage is about 300 volts, but up to 1000 volts may be applied without damage.

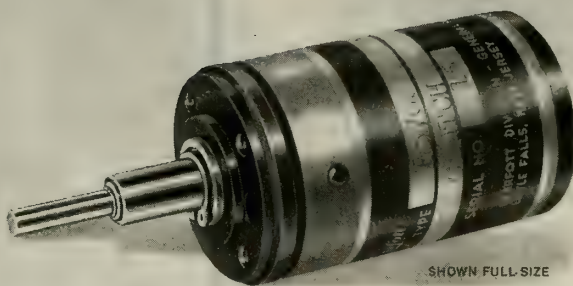
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## Low-Noise Amplifier

Keithley Instruments Model 103 is a d-c preamplifier intended to give the best possible signal-to-noise ratios for oscilloscopes and recorders. It has a noise level of less than 0.8 microvolt rms between 10 cps and 10 kc. The unit lowers the microvolt measurement threshold over a bandwidth of 0.1 cps to 100 kilocycles. Bandwidth can be selected by using 11 high- and low-frequency cutoffs between 0.1 cps and 10 kc. Noise level can be altered by means of a "normal" (input impedance 1 megohms) switch and a "low noise" (input impedance at least 100 K ohms) switch. Amplifier gain may be set at either 100 or 1000 and adjusted to precise values.

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|------------------------------|---------------------------------------|-------------------|---------------------------------------|----------------|
|                              | R5750-001                             | R5750-002         | R5760-001                             | R5770-001      |
| Power input<br>(Watts)       | 3                                     | 3                 | 3                                     | 3              |
| Clutch Torque<br>(In. Oz.)   | 6 (energized)                         |                   | 4 (energized)                         | —              |
| Brake Torque<br>(In. Oz.)    | —                                     | —                 | 6 (de-energized)                      | 16 (energized) |
| Inertia (gm cm $^2$ )        | .82 (energized)<br>.56 (de-energized) |                   | .82 (energized)<br>.56 (de-energized) | .34            |
| Engaging<br>Surfaces         | Steel                                 | Brake<br>Material | Steel and<br>Brake Material           | Steel          |
| Environmental<br>Performance | Per MIL-E-5272A                       |                   |                                       |                |
| Life (Cycles)*               | 3,000,000                             |                   |                                       |                |

\*1 Cycle=1 revolution of shaft engaged and 1 revolution of shaft disengaged, at 500 RPM.

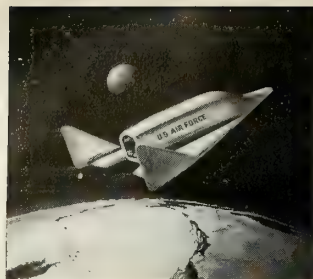
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**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

Little Falls, New Jersey

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## Senior level DYNA-SOAR SPACE GLIDER structural design openings

One of the most advanced programs in the country, the Dyna-Soar manned space glider, offers structural design engineers immediate openings of significant scope and challenge. Positions are with the Aero-Space Division of The Boeing Company, system contractor for Dyna-Soar.

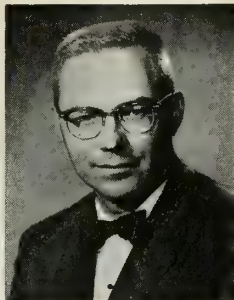
The Dyna-Soar glider, in returning to earth from space, experiences a flight regime ranging from orbital to normal landing speeds, and is subjected to extreme air loads and temperatures with attendant high heating rates, high differential temperatures, oxidation of materials, material creep and elongation. These conditions, requiring innovations in structural concepts and testing techniques, offer assignments in such advanced design areas as wing leading edges and surfaces, fuselage and wing primary structure, windows and window mounts, and nose cap.

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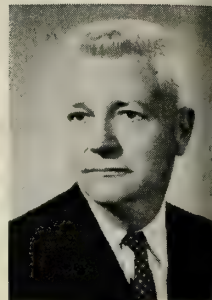
## names in the news



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**Dr. Leo S. Packer:** Former chief engineer, appointed manager, Military Products Div., Bausch & Lomb Incorporated, Rochester, N.Y.

**H. E. Jones:** Executive vice president, Electralab Printed Electronics Corp., and a vice president of the parent Farrington Mfg. Co., Needham Heights, Mass., appointed senior vice president in charge of Electralab and three other subsidiaries.

**Arthur J. Raymo:** Formerly with Baldwin-Lima-Hamilton Corp., joins Kansas City division of The Bendix Corp. as director of manufacturing. The division is operated by Bendix for the Atomic Energy Commission.

**Al Lujack:** Washington, D.C., insurance executive and manufacturer's representative for over 20 years, appointed government representative for MPI Glass Fibers, Inc.

**Philip S. Hessinger:** Manager, Research & Development Div., and **Adolf J. Strott,** manager, Manufacturing Div., named vice presidents, National Beryllia Corp., Haskell, N.J.

**J. J. O'Brien:** Manager of The Garrett Corp.'s AiResearch Mfg. Div. of Arizona, and a member of the Garrett board of directors, named a vice president of the corporation. **Jack Lewis,** formerly director of manufacturing for Garrett, named vice president in charge of manufacturing.

**Arnold A. Toivonen:** Former assistant manager of Rocket Mfg. Div., appointed manager, Technical Services Div., Aerojet-General Corp.'s Solid Rocket Plant, Sacramento, Calif. Toivonen replaces **W. J. Hix,** named assistant manager of operations at Aerojet's Azusa, Calif., plant.

**John A. Vaughan:** Appointed manager, DuMont Military Electronics Dept., Fairchild Camera and Instrument Corp.'s Defense Products Div., Syosset, N.Y. Prior to joining Fairchild, Vaughan was manager of projects support, RCA's Missile and Surface Radar Dept.

**W. C. Loeman:** President, Parker Aircraft Co. Div., and **S. A. Rogers, Jr.,** presi-

dent, Parker Seal Co. Div., elected vice presidents of the parent company, Park Hannifin Corp.

**Bernard M. Wilner:** Joins Electro Optical Systems, Inc., Pasadena, Calif., principal scientist, Fluid Physics I. Formerly Wilner was project manager of the SNAP-8 power conversion system at Aerojet-General Corp.

**John R. O'Brien:** Appointed corporate director of government relations, Hoffmann Electronics Corp., and will continue as manager of the Washington, D.C., office and a vice president of the Military Products Div.

**J. D. Schetzer:** Appointed associate director, Aerospaces Laboratory; **James Dunn,** named senior staff engineer; **Robert C. Anderson,** associate director, Propulsion Laboratory; Mechanics I Space Technology Laboratories, Inc., Angeles.

**T. H. Beck:** Veteran of more than 20 years' experience in aeronautical engineering and former engineering manager, Product Development, named director of engineering, Aerospace Div., Ryan Aeronautical Co., San Diego.

**James W. McNabb:** Former head of Communications Sciences and Systems Dept., The Bendix Corp., appointed assistant general manager, Strand Engineering Co., Ann Arbor, Mich. Other appointments are: **Richard Eschelbach,** supervisor, Theoretical Analysis Dept.; **Leonard Newland,** responsible for planning marketing activities; and **Robert H. Johnson,** responsible for development of processing and display systems. Strand Engineering is a division of Datronics Engineers, Inc., Bethesda, Md.

**William A. Ogletree:** Appointed general manager, Sarasota Products Div., Electro Mechanical Research, Inc. Before joining EMR, Ogletree was vice president and general manager, Computer Systems. **James R. White** named manager of Satellite Integration Facility recently established by EMR in College Park, Md. Previously White was a senior aeronautical scientist at NACA, Langley Field, Va.

missiles and rockets, October 9,



# contracts

## NASA

\$6,650—J. W. Fecker Div., American Optical Co., Pittsburgh, Pa., for development of a sidereal test stand for testing gyroscopes and other inertial guidance components.

## MISCELLANEOUS

\$25,997—B. F. Goodrich Aerospace and Defense Products Div., from Navy and Air Force, for *Sidewinder* rocket motors, aircraft tires, de-icers and glare shields for fighter aircraft.

\$100,000—General Dynamics Corp., Electric Boat Div., Groton, Conn., from Reynolds International, Inc., for design and construction of aluminum research submarine.

\$10,000—Adler Electronics, Inc., from RCA, for production of high-frequency, single-sideband, dual-diversity receivers.

\$10,000—Microwave Associates, Inc., from Western Union Telegraph Co., for microwave tubes for use in transcontinental microwave beam system.

## NAVY

\$1,000,000—General Dynamics Corp., Pomona, Calif., for additional production of advanced *Terrier* and *Tartar* guided missiles.

\$937,758—Bendix Radio Div., Bendix Corp., Powson, Md., for operation and maintenance of downrange instrumentation facilities along Pacific Missile Range.

\$845,000—Bendix Corp., Mishawaka, Ind., for development of first phase of long-range *Typhoon* missile.

\$91,327—Northern Ordnance, Inc., Minneapolis, for additional production of *Tartar* guided missile launching systems.

\$100,000—Massachusetts Institute of Technology, Cambridge, for research and development of *Polaris* missile guidance.

\$28,950—International Telephone & Telegraph Corp., Fort Wayne, Ind., for target detecting devices for *Terrier* missiles.

\$118—Maxson Electronics Corp., from BuWeps, for production of anti-submarine detection devices (two contracts).

\$650—Scope, Inc., Falls Church, Va., for engineering and production of countermeasures set AN/TLQ-14.

## ARMY

\$1,821,000—Western Electric Co., North Carolina, for development and testing of *Nike-Zeus* system for an additional 12 months.

\$100,000—General Dynamics Corp., Pomona, Calif., for continued development of the *Mauler* missile system.

\$4,552—Raytheon Co., Waltham, Mass., for engineering services and documentation on *Hawk* missile system.

\$100,000—Continental Electronics Mfg. Co., subsidiary of Ling-Temco-Vought, Inc., for design of a multimegawatt radar transmitter for *Nike-Zeus*.

\$5,000—Western Electric Co., Winston-Salem, N.C., for production of components for *Nike-Hercules* missile system; \$1,500,000 for engineering documentation on *Nike-Ajax* and *Nike-Hercules* systems.

\$200—Electronic Associates, Inc., Long Branch, N.J., for a large transistorized analog computer.

## AIR FORCE

\$10,000—Kollsman Instrument Corp., subsidiary of Standard Kollsman Industries, New York City, from North American Aviation, for astro tracker systems and *Hound Dog* missiles.

\$10,000—General Telephone and Electronics Corp., Sylvania Electric Products, Inc.,

Mountain View, Calif., for engineering and production of receiving equipment.

\$2,000,000—General Electric Co., Defense Systems Dept., Syracuse, N.Y., for precision trajectory measurement systems for tracking ballistic missiles.

\$2,000,000—AC Spark Plug Div., General Motors Corp., Flint, Mich., for special training of Air Force personnel in depot-level maintenance on *Titan* ICBM inertial guidance system.

\$1,700,000—Republic Electronics, Farmingdale, N.Y., for production of single-sideband radio systems.

\$1,430,500—Hughes Aircraft Co., Culver City, Calif., for production of components, spare parts and data for radar sets.

\$600,000—Pacific Semiconductors, Inc., Hawthorne, Calif., from The Boeing Co., for electronic parts for *Minuteman* ICBM program.

\$58,000—Avien, Inc., Woodside, N.Y., for study to determine feasibility of array-type antennas for use in missile tracking and telemetry systems in super-high-frequency band.

\$50,000—General Electric's Specialty Control Dept., Schenectady, N.Y., from Lockheed Aircraft Corp., for high-reliability sealed relays for use in space vehicles.

## OPPORTUNITIES

Anti-missile Missile Systems Div., Industrial Operations, Army Rocket and Guided Missile Agency, U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.

The Army Rocket and Guided Missile Agency, through the New York Ordnance District, proposes to award a supplement to the *Nike-Zeus* research and development contract with Western Electric Co., Inc.

The proposed supplement will provide for continued system development from 1 Oct. 61 through 31 Sept. 62.

Competitive solicitation is precluded because of the continuing nature of the effort and initial development.

This synopsis is to publicize possible subcontract opportunities and all inquiries relative to subcontracting must be referred to the selected prime contractor—Western Electric Co., Inc., 222 Broadway, New York 38, N.Y.

Directorate of Procurement/FTKRS, Headquarters, Air Force Flight Test Center, Edwards Air Force Base, Calif. Research and Development sources sought—Program Area 750G.

Firms having research and development capabilities in the field of liquid rocket engines and whose facilities and personnel are qualified to undertake practical studies, hardware design, and testing associated with energy propellants are invited to submit complete information to the purchasing office listed above.

The contemplated effort will be to investigate the technical problem areas associated with the utilization of high-energy propellants in rocket engines. The engine is to utilize advance design concepts in hardware design. Performance demonstrations will be made at the 25,000 to 50,000-lb. thrust level.

A contract of nine months duration is contemplated.

It is important that the company selected to perform these services must have a demonstrated experience in high-performance liquid rocket engines. Respondents should have technical personnel with experience in design, development, fabricating and testing of liquid rocket engines. Among the personnel required will be designers, test engineers, metallurgists and chemists.

Information provided should include the total number of employees and professional qualifications of scientists, engineers and technical personnel, a description of general and special facilities, and outline of previous projects, other available descriptive literature, and a statement regarding industrial security clearance, if previously granted.

For further details, contact G. L. Rucker Wells.

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Technical degree and minimum 10 years experience required.

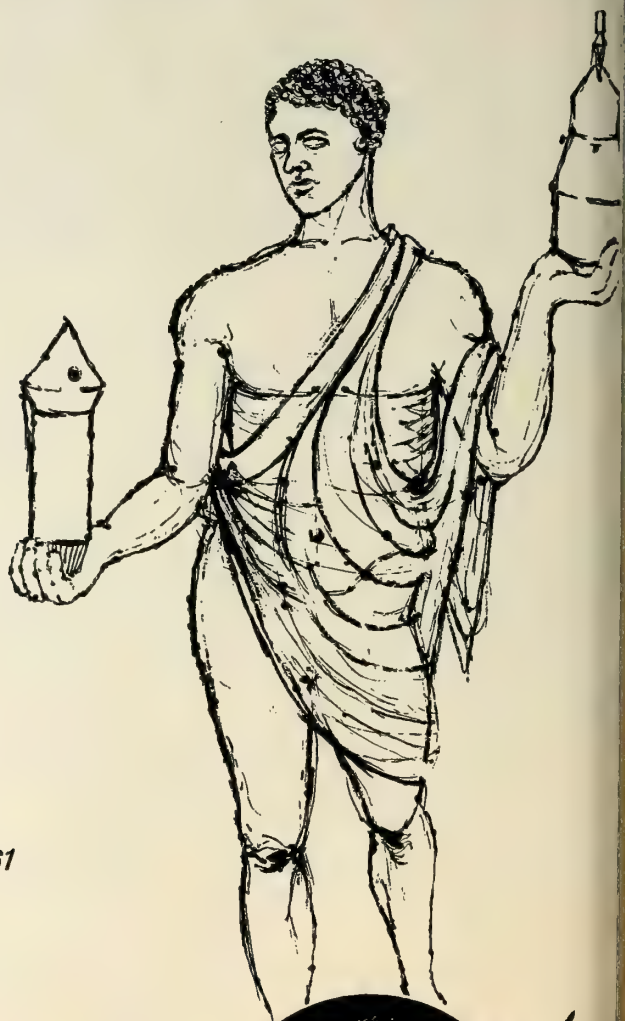
Other positions are also available to Engineers who can contribute to the team effort. Similar background and 5 to 10 years experience required.

Forward written inquiries in confidence to

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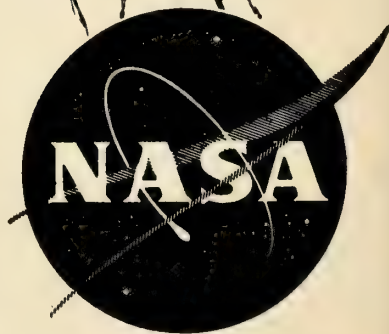
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## when and where

### OCTOBER

**17th National Electronics Conference and Exhibition**, International Amphitheatre, Chicago, Oct. 9-11.

**National Aeronautic and Space Engineering and Manufacturing Meeting**, sponsored by Society of Automotive Engineers, Hotel Ambassador, Los Angeles, Oct. 9-13.

**Space Flight Report to the Nation**, American Rocket Society, New York Coliseum, New York City, Oct. 9-15.

**American Standards Association National Conference**, Rice Hotel, Houston, Oct. 10-12.

**Symposium on Shock, Vibration and Associated Environments**, sponsored by DOD, Office of Director of R&E, Detroit, Oct. 10-12.

**Optical Society of America Meeting**, Somerset Hotel, Boston, Oct. 12-14.

**17th Annual ISA Instrument-Automation Conference and Exhibit**, New York Coliseum, New York City, Oct. 15-19.

**American Society of Tool Engineers Semi-Annual Convention**, Royal York Hotel, Toronto, Oct. 16-18.

**Second International Congress, International Organization for Vacuum Science and Technology**, Eighth Annual Symposium of the American Vacuum Society, Washington, D.C., Oct. 16-19.

**National Conference on Industrial Hydraulics, Versatility and Reliability of Fluid Power**, Sherman Hotel, Chicago, Oct. 19-20.

**National Society of Professional Engineers Fall Meeting**, Roanoke Hotel, Roanoke, Va., Oct. 19-21.

**East Coast Conference on Aerospace and Navigational Electronics (ECCANE)**, Lord Baltimore Hotel, Baltimore, Oct. 23-25.

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## Russian Boosters

(Continued from Page 41)

Besides the Russian practice of making each new rocket design a major step forward rather than a minor modification, the estimate of 3 million lbs. or more for the thrust of the new rocket, is supported by Khrushchev's recent statement that they now knew how to land a man on the moon but were not yet prepared to bring him back. A 3-million-lb.-thrust booster (*Saturn C-3* thrust) should be adequate for "moon-  
ing" a man (as Khrushchev says), but only marginal for "demonooning" him.

The space payload growth curve (Figure 2) which is an indication of maximum capability during a given time period, indicates a Russian capability for 25,000 to 30,000-lb. payloads in orbit in the first half of 1962, if they chose to use this period to make a major advance in capability. Successful orbiting of such payloads would be a strong indication that they had in fact doubled their booster thrust as estimated. Use of hydrogen-oxygen propulsion for upper stages could increase this payload capability by another factor of two.

If these booster and payload advances develop as indicated on Figures 1 and 2, then we can expect Russian attempts at manned cislunar and circumlunar flights in the next two years.††

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## A Lesson From the Past

**WE** USUALLY DO NOT concern ourselves on this page with book reviews. They appear elsewhere in the magazine. But there is a book just out which we feel everyone connected with the missile/space industry should read. Indeed, the nation would benefit if every American could read it, including the President.

The book is "Combat Missileman." Its authors are Bill Howard, our managing editor, and Jim Baar, our senior editor for military affairs.

Do not let the perhaps unfortunate title deceive you. "Combat Missileman" effectively covers a much more sweeping area than its name implies. Its punch lies in its blunt analysis of the politics and military strategy which underlie our missile and space programs.

It paints in the clearest way the danger facing this nation today as a result of the indecisiveness which afflicted the start of our missile and space programs.

Through careful research and good reporting, the authors lead you back to the sticky summer of 1953 when Trevor Gardner, then Air Force special assistant for research and development, together with Convair's Charlie Bossart and William Patterson, was fighting for an all-out ICBM effort. It is very pertinent to be reminded of that situation eight years ago:

"Many officials in the Administration and the Air Force remained opposed to beginning a top-priority program to develop an ICBM. The Administration did not want to spend the billions of dollars that would be needed."

This, at a time when the Soviet Union already was far along with its own ICBM program.

We are calling your attention to this book on this page today because the nation once again stands at a decisive crossroads for an important military program. We are talking about the *Nike-Zeus* antimissile missile.

If there is a single clear lesson to be learned from the mistakes of the past, it is that we should not underestimate Soviet capabilities. When the U.S. began its development of the *Atlas* ICBM, there still were many who said that such a missile was an impossibility, that it could not by any stretch of the imagination perform its task of hurling a nuclear warhead onto a target 5000 miles away.

The decision to push ICBM development in the face of those doubts was a carefully calculated risk, a decision that the nation could not afford NOT to spend the money. "Concurrency" became the catchword.

The *Nike-Zeus* stands today in the same position.

There are many who will tell you that the *Nike-Zeus* cannot handle its mission of knocking down incoming ICBM's. There are others who will argue that enemy ICBM's can be attacked more effectively

during launch than during the terminal phase of their awful journey. Project *Defender* seeks better ways of tackling the same problem. The Air Force is hopeful that the *Saint* program will provide a satellite force to knock down ICBM's well before the re-entry stage.

Be that as it may—and we wish all other efforts well—*Nike-Zeus* is the only program which offers a possibility of an "early" ICBM defense.

Word in Washington this week is that the latest review of U.S. military programs by President Kennedy and Defense Secretary McNamara has reaffirmed the decision to withhold production funds from *Nike-Zeus* until at least next year.

If production is ordered after the Pacific tests, emplacement of the antimissile missile around U.S. cities cannot begin for another four years—in 1966.

A go-ahead now for long-lead time production items would shave valuable time off that schedule.

Balance the doubts about *Nike-Zeus* against the optimism of the industry and military team which has been working on the program since its inception. Then concede there still is a possibility it might not work effectively.

**E**VEN WITH THIS concession, can we afford to lose the time-saving offered by an immediate production go-ahead? We never will be convinced that a country rich enough to afford our present standard of living cannot afford the amount of money involved in risking a production start for *Zeus*.

The ugly fallout from Soviet nuclear testing in the Arctic has been followed by reports that the Russians are testing warheads for an antimissile missile.

If anyone has any doubts about the need for deployment of *Nike-Zeus* at the earliest possible date, let him ask himself this question: What happens to the U.S. military posture if the Soviet Union equips itself with an effective antimissile system before this country does?

The answer is that minimum deterrent and counterforce then become theoretical arguments. The first nation to develop such an antimissile system gains an overwhelming military advantage.

Let us remember the summer of 1953:

"Many officials in the Administration and the Air Force remained opposed to beginning a top-priority program to develop an ICBM. The Administration did not want to spend the billions of dollars that would be needed."

Then let us ask what our military and political relationship with the Russians would be today if the decision had gone against the U.S. ICBM program. That is argument enough for a production go-ahead on *Nike-Zeus*.

William J. Coughlin





groundbreaking

▶▶ Some day — not far away in time — earthbound intelligence will set up base on the moon.

▶▶ First, perhaps, the robot explorer, such as the "Moonmobile," designed and developed by Space-General Corporation, answering many of man's questions about his celestial neighbor. Ultimately — groundbreaking — and the return to earth of the first substance from a foreign planet.

▶▶ Soft lunar landings have been studied in depth by Space-General Corporation, America's uniquely capable source for space systems. Space-General's management and staff have been part of this nation's ICBM, IRBM and space programs since the earliest days. Familiar accomplishments include the reliable Ablestar space engine. Others are in the making — advanced launching vehicles, commercial and navigational satellites, space-based weapon systems and nuclear-powered space vehicles.

▶▶ These programs now create opportunities for scientists and engineers. Those capable of bringing high levels of skill and energy will be considered without regard to race, creed or national origin. Contact Pierre Brown, 777 Flower St., Glendale, Calif.

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## How to swat a hornet in flight

Swatting hornets can be tricky. Especially if the hornet happens to be an enemy missile.

Fortunately, we've got the best hornet swatter ever made. It's called Nike Zeus. What makes the Nike Zeus anti-missile missile so effective? An important factor is the Target Intercept Computer System developed by UNIVAC®. This system tells Nike Zeus *exactly* where to go to kill a fast-moving target, as far as 100 miles away.

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cellent reliability records. Mean-time-to-failure design goal is an average of over 600 hours . . . and it is expected to attain greater reliability than any comparable computer in existence today.

One more example of how UNIVAC's team of scientists, mathematicians, physicists, engineers and technicians is capable of creating efficiency and reliability for today's defense systems. If you're in the systems business, talk to UNIVAC. We're pioneers.

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OCTOBER 16, 1961

# missiles and rockets

THE MISSILE / SPACE WEEKLY



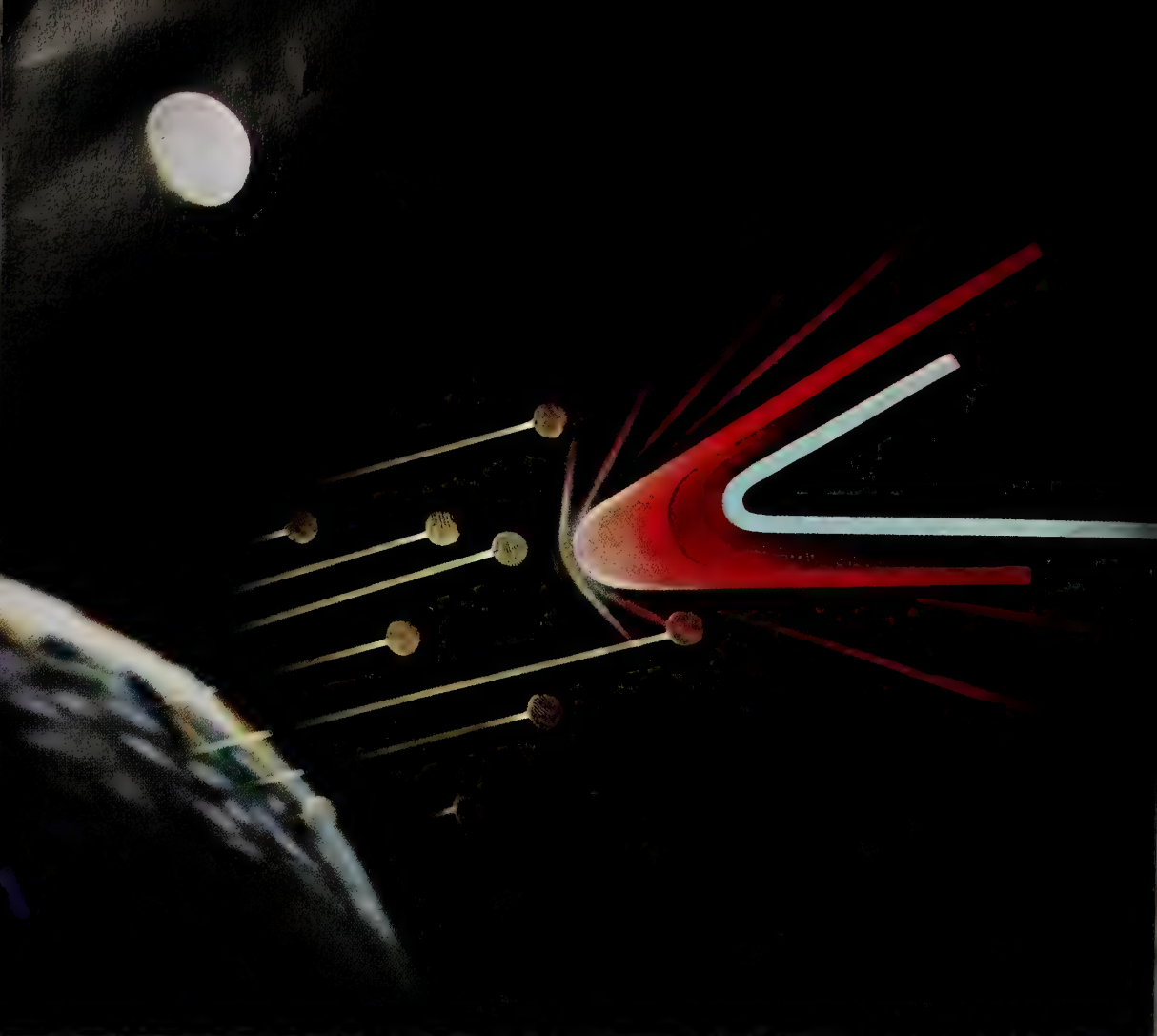
ell. Communications Satellite

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AN AMERICAN AVIATION PUBLICATION



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## BELL COOLS THE HEAT OF HOMECOMING

Atmospheric friction which will slow tomorrow's returning space vehicles to safe landing speeds can make cinders of both space ship and occupants.

Bell Aerosystems has worked since the days of the X-1 supersonic research plane to beat this heat. We call our system Double-Wall. We've tested it — and we know it works.

Double-Wall is made up of a heat-sustaining outer wall, a sublayer of thermal insulation and a cooled inner wall. The fundamental principle behind this arrangement is the separation of the heat-sustaining and load-carrying functions of the airframe.

The outer wall is made up of small heat-resistant panels designed to withstand severe heating. It carries no structural loads, but serves as an effective heat shield by radiating most of the re-entry heat back to the atmosphere.

The layer of protective insulation is used beneath these

panels to resist the flow of heat to the inner wall. The small amount of heat that does penetrate this insulation is absorbed and dissipated by an effective cooling system. Therefore, though outer wall temperatures may soar above 2000°F, the inner wall temperature will not rise above 200°F.

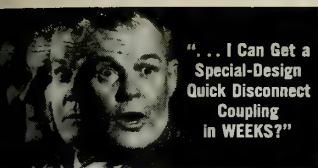
Significantly, the load-carrying structure is kept cool and strong, independent of external heating, and conventional aluminum construction can be utilized. As an added bonus, the Bell Double-Wall's unique arrangement of thermal barriers automatically provides a moderate environment for both crew and equipment.

Double-Wall is only one of the many contributions Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing in this challenging and rewarding future.



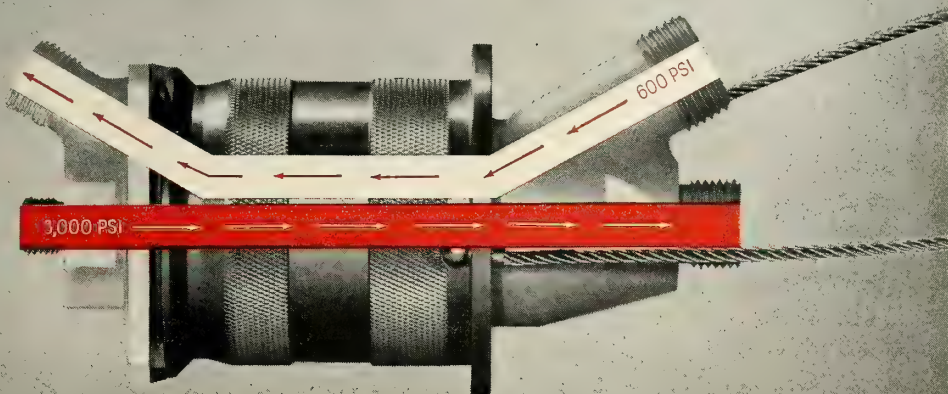
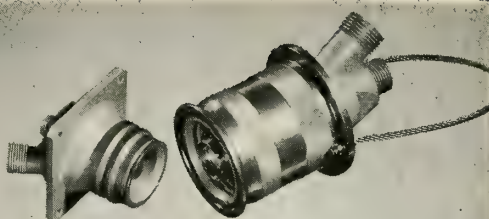
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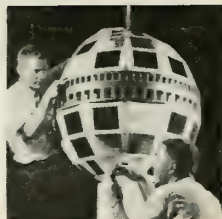
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**THE COVER**

A popular exhibit at the ARS meeting was this full-scale model of Bell's experimental active communications satellite, due for first launch in April. See p. 48.

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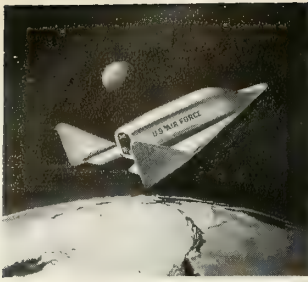
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## letters

### Too Much Organization

To the Editor:

Upon my return from a trip to Europe last week I found your editorial ("Apollo Beset by Avarice") in the Aug. 28 M/R.

You have a good point and I too am very much concerned that we may end up second best in both aircraft and space. The reason for all this I am sure is our present over-organization. While large projects admittedly require large organizations, we seem to have gone too far and are, I am afraid, losing our capability to produce economically and quickly.

Keep up the good work. Perhaps if we all keep at it we may be able to influence the situation favorably.

E. H. Heinemann  
Executive Vice President  
Guidance Technology, Inc.  
Santa Monica, Calif.

### Early Flare Warning

To the Editor:

In M/R, Aug. 7, p 30, Mr. William Beller writes in his article: "Solar Ray Storm Prediction Improved": "The danger of solar streams to astronauts was first recognized when a flare on May 12, 1959, sent protons of extremely high energies throughout the solar system."

May I point out that this danger was predicted in a paper to the 6th Astronautical Congress held in Copenhagen, 1955. Parts of it were repeated in a lecture to the 10th Astronautical Congress held in London in 1959. The title of the original paper was "The Great Danger: The Corpuscular Rays From the Sun."

For various reasons, it was concluded that the sun sometimes ejects plasma at speeds exceeding the gravity escape speed. There are different forms of ejection. The very interesting, but infrequent, surge eruptions go perpendicularly away. The luminous clouds are sometimes quite separated from the ejection point and may proceed as "shots," as directly observed.

Such clouds of charged particles will, under certain conditions, proceed collected instead of spreading (W. H. Bennett, Phys. Rev. 1955, v.98, p. 1584-1593).

On the other hand, it may presumably stretch out.

If the acceleration process in the sun is of electromagnetic nature, the electrons should presumably have energies of the same order as the protons, though they should not have greater stream speeds.

When a particle stream hits the earth's atmosphere, the nuclei will have definite path lengths and penetration depths. From the observed data, the energies were calculated to be often about  $10^6$  electronvolts. But, as the particles are spiralling, their real path lengths and energies must be much greater.

From the intensity of the aurora light when brightest, the energies were calculated to be  $3 \times 10^{-3}$  cal.cm<sup>-2</sup> sec<sup>-1</sup> in extreme cases; i.e.,  $10^5$  erg or  $10^{17}$  ev. With

a factor of  $10^2$  for the whole spectrum, result would be about  $10^{19}$  ev.

When this amount was compared with the energy per particle, the particle turned out to be about  $10^{12}$  cm<sup>-2</sup> sec<sup>-1</sup> the energy per particle was  $10^6$  ev. This was almost as much as the flux of a beam from a small cyclotron. But the streams would be much more dangerous because of the presence of electrons, give rise to X-rays.

I mentioned that if only  $1^{-4}$  of the energy coming in per cm<sup>2</sup> was transformed into X-rays being absorbed in 1 cm<sup>3</sup> flesh, the average dose would be about roentgen per sec.—than the lethal dose.

The Copenhagen paper also dealt with another form of particle emission from the sun—observed only at high geomagnetic latitudes, coming in outspread form only during the half of the sun revolution period, not associated with sun spots.

Dr. Johannes Olsen studied this phenomenon in Northern Greenland by magnetic methods and traced them continuously from 1926 to '41—that is, through about 200 sun-revolution periods (C. magnetism and Atmospheric Electricity 1948, p. 123-34).

It seemed evident that the sun has unfriendly and a friendly side when it is apart from the sun-spot areas (polar flare areas). Hence I suggested that human space flights should be undertaken only when no sun spots are facing earth and only when the sun turns friendly face towards us.

Now, one would also claim other conditions. But this suggestion was made long before the recent discoveries.

In London, I also called attention to this problem: If any radiation may be measured to show the periodicity of 26.83 days calculated by Dr. Olsen, conclusion is that its origin is in the sun.

Dr. Olsen has, from the remarkable constancy of the periodicity and its durability compared to the different revolution times and the short lives of the spots, suggested that radiation in question originates deep in the sun.

Hence, one must assume that the particles were neutrons when ejected from the sun, and later disintegrated protons (representing another danger).

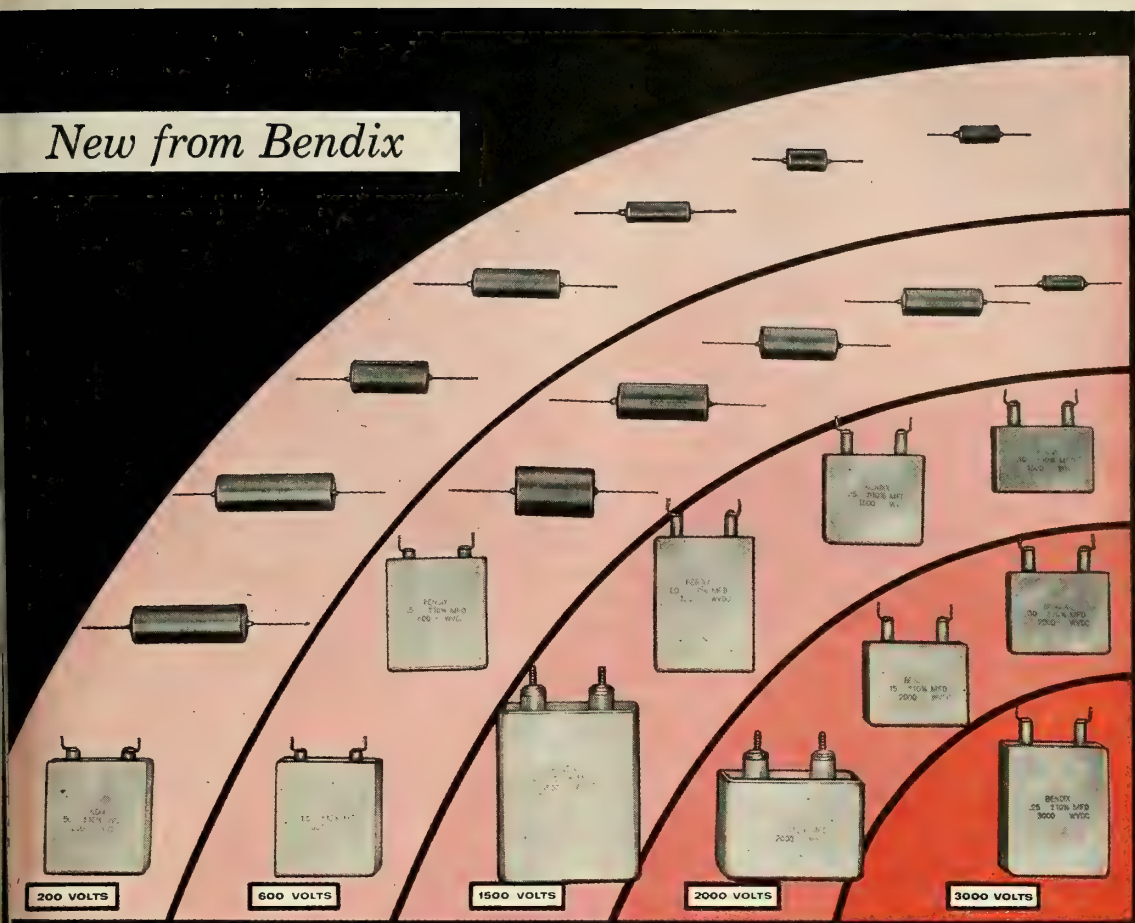
From this it follows that any confirmation of a 26.83-day period will be proof of a phenomenon developing from plasma material deep under the glowing surface of the sun. . . .

Carl E. Andersen  
Technical University  
Copenhagen  
Denmark

Satellite and rocket measurement of the lethality of solar radiation bears Dr. Andersen's contentions, reached theoretical means years earlier. Cf. p. by Russian scientist V. I. Kravosvsky, "The Hardest Solar Corpuscles," presented XII International Astronautical Congress 1961, Wash., D.C.—Ed.



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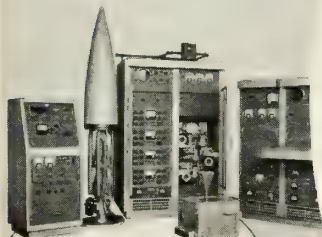
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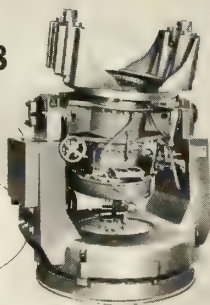
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BULLETIN T818/T918

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# The Countdown

## WASHINGTON

### Zeus: The Question Remains

Despite reports to the contrary, neither the White House nor Defense Secretary McNamara has decided to push for *Nike-Zeus* production in FY '63. To date, DOD guidelines are reported to call only for continued R&D; deployment plans remain on the shelf.

### How Many Polaris Subs?

Defense Department is still juggling various number combinations in connection with authorizing more *Polaris* submarines in FY '63. The hardest figure to date is six and six: a package authorizing six additional ships and long-lead-time items for six more. That would bring the total number authorized in FY '63 to 35 and presumably 41 in FY '64.

### Pentagon Again Looks at the MRBM

Defense Department interest in development of a new MRBM with a range of about 1000 miles is once more on the rise. This is favored over use of an upgraded *Pershing* or a modified *Polaris*.

### NASA vs. the Military

A controversial report calling for general supervision by NASA of all Defense Dept. R&D for military space communications has been issued by the House Space Committee. This could result in a lively battle. The committee says NASA should supervise the work since its statutory authority directs the agency to "plan, direct and conduct, aeronautical space activities."

### Cost of Mobile vs. Fixed

Air Force estimates on the cost of mobile *Minuteman* show that the system is expected to cost about 2.5 times as much per missile as the fixed-base model. The Defense Department is proposing a resumption of new funding for the mobile R&D program under the present guidelines for the FY '63 budget.

### Ambitious NASA Space Planning

NASA's advanced space planners believe large manned space stations in a 300-mi. earth orbit will be feasible in 1968-69; a permanent manned moon station will exist in 1970 and can be expanded into a lunar colony by 1975; manned planetary expeditions can start in 1972-74 with a view to the arrival of a 100-man expedition on Mars in 1980; the U.S. will be able to support 500 roundtrips to the moon in 1975 without undue strain on the national budget; commercial passenger and cargo space flights will be economically feasible in 1975-80.

### Senate Booster Hearings Rescheduled

The Senate Space Committee has tentatively rescheduled its public hearings on the *Centaur* and *Saturn* launch vehicle programs for sometime in November. No final date will be set until committee chairman Sen. Robert

Kerr (D-Okla.) returns from a fact-finding trip to NASA and industry West Coast locations. Hearings also will consider other aspects of the U.S. space program.

## INDUSTRY

### Booster Proposed for X-15

NASA is not enthusiastic over a proposal that a two-stage *Blue Scout* rocket be used as a recoverable booster for a surface launch of the *X-15*. Proposal is being pushed by Aeronutronic and North American Aviation.

### Exit Discoverer, Enter Ranger

*Discoverer XXXIV*, last of the successful Lockheed series, now is being readied on the launch pad at Vandenberg AFB. The *Thor* pad will be modified at a cost of \$500,000 for future NASA use. . . . Also ready to go is *Ranger II*, scheduled for launch this week from Cape Canaveral. It will carry the same equipment as the ill-fated *Ranger I* which burned up in the earth's atmosphere in late August after failing to achieve its highly elliptical orbit.

### Saturn Bids Due

Only 10 of the 37 firms invited to bid on the *Saturn C-1* contract are expected to submit bids by the Oct. 16 deadline. They will include Aeronutronic, Boeing, General Dynamics/Astronautics and Chrysler.

## INTERNATIONAL

### Germans Count Russian Missiles

*Bundeswehr*, official publication of West Germany's armed forces, says the Soviet Union will have 200 intercontinental missiles available this winter. The magazine says the Soviets have 35 to 50 *T-3* missiles now operational, with a rapid production buildup to make 150 more available in the winter of 1961/62. It reports that ten launching bases are operational and sites for an additional 27 bases are known.

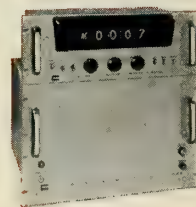
### French Space Budget Disclosed

The new French budget earmarks the equivalent of some \$18 million for missile/space research. A little more than half of this will be used to finance domestic projects, including work on a ballistic missile whose engine could be used to boost a 100-lb. satellite into orbit in 1964-65. The remainder of the funds will be spent on European cooperative programs.

### Getting Ready for Vostok III?

Russia's space tracking ships were last reported to be taking on supplies at a North African port—possibly in preparation for the launching of *Vostok III*. There has been speculation in western capitals for weeks that the Soviets will time *Vostok III* for the party congress in Moscow later this month—or for the anniversary of the revolution in early November.

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## Non-Profit ComSat Plan

A special industry committee was ready last week to recommend that a non-profit corporation be set up to own and operate a commercial communications satellite system (M/R, July 31, p. 17).

The report by a 10-member group of international communications carriers was due at the Federal Communications Commission on Oct. 13.

The non-profit corporation's board of directors would have equal representation by all carriers using the system, plus public members appointed by the President.

The contributions of each of the carriers to the capital of the corporation would be equal to their use of the system.

Ground stations would be owned by the carriers using them. Two members of the committee, RCA and Western Union, were expected to file a dissenting report which calls for the corporation to own the ground stations to insure that all carriers will be able to use them.

Another provision of the ownership plan is compulsory competitive bidding on all purchases of supplies and equipment.

Submission of the report will kick off further controversy and discussion in Congress and the Kennedy Administration over who should control and reap the benefits of the first commercial outgrowth of space technology.

The Senate Monopoly Subcommittee has already scheduled hearings on Nov. 8 and 9 on the industry's ownership plan.

Discussions also have been held within the Kennedy Administration for possible alternative ownership plans in the event that the industry's plan is declared inadequate.

Among those considered was an interim government ownership setup.

Administration officials want to insure that private ownership of the system does not result in one or more large carriers controlling the system. They also want to insure that the system is open to all foreign countries which want to use it.

Although the FCC regulates communications carriers, a final decision on ownership will probably be made

missiles and rockets, October 16, 1961



## Bullpup B Getting to Know Skyhawk

A COMPATIBILITY PROGRAM mating the Navy's Bullpup B missile with the Douglas A4D now is well advanced. Three of the Bullpups are shown here under the wing of the Skyhawk. Grumman's A2F-1 is being flight-tested carrying a load of five Bullpup B's.

within the Administration, with the National Space Council, NASA and the Justice Department playing major roles. NASA will also be given the role of setting the equipment requirements for the system, plus the launching of all satellites.

## Shots of the Week

- A Nike-Zeus destroyed itself several seconds after launch Oct. 7 in the AICBM's second failure within a month. Army officials said the first stage operated successfully and dropped away as planned. The second stage exploded. Apparent cause of failure—break in signals from the guidance radar.

- An Atlas landed in the Indian Ocean, Oct. 5, 9000 miles from its Canaveral launch site, in a nose cone re-entry test. The missile, fired on a shallower than normal trajectory, was subjected to severe re-entry stresses and heating. Its data capsule was recovered in the first retrieval from a shot of this length.

- The Soviet Union fired another of its new type rockets into the Central Pacific Oct. 7. The Soviet news agency Tass said it carried a new guidance system and travelled more than 7500 miles, impacting in the target area.

- A Titan I with a guidance system scheduled for use on Titan II flew 5000 miles down the Atlantic

Missile Range Oct. 6. Titan box score: out of 41 shots, only 10 failures.

- NASA fired an Argo D-4 from Wallops Island Oct. 10. The solid-fueled, four-stage rocket traveled 817 miles out over the Atlantic and reached an altitude of 585 miles. The mission was to determine density of electrically-charged helium atoms in the upper atmosphere.

- A Pershing, preset to perform a series of erratic in-flight maneuvers, struck "on-target" after a 150-mile flight down AMR Oct. 10. Preliminary data indicated all test objectives were met.

- Air Force Maj. Robert White piloted the X-15 to a record 215,000 ft. on Oct. 10. This bettered its previous altitude record by almost seven miles.

## Apollo Bid Teams Announced

NASA has confirmed that five firms—GE, Martin, McDonnell, General Dynamics/Astronautics, and North American Aviation—have submitted bids for the prime contract on the Apollo spacecraft (M/R, Oct. 9, p. 10).

The GE bidding team consists of Douglas, Grumman and Space Technology Laboratories. The McDonnell team includes Hughes, Lockheed, and Chance Vought. The other three firms

bid alone. Hour-long presentations were made on each of the bids to members of NASA's Space Task Group. An evaluation panel has been set up to make a recommendation on the bids to NASA headquarters.

### Space Flight Meeting

NASA Administrator James E. Webb told the ARS meeting in New York last week that the space agency's facilities and programs will have the flexibility to take advantage of either rendezvous or direct flights to the moon.

He said that as far as rendezvous is concerned, "NASA is proceeding with the necessary fact-finding."

Sen. Warren G. Magnuson (D-Wash.) told the meeting that immediate government planning of radio frequency allocations for satellite communications is a necessity.

These, the Senator said, should be ready in time for the 1963 International Telecommunication Union's conference at which 108 member nations will determine frequency or

bandwidth allocations for the system.

Dr. James A. Van Allen, discoverer of the Van Allen radiation belts, told a luncheon session that the nation's ambitions in space exploration have greatly outrun its basic scientific competence in space science.

He suggested financial aid to universities for studies in such fundamental fields as physics, chemistry, celestial mechanics and atmospheric research. The Iowa scientist said the initiative for the funding should come through NASA and the National Science Foundation. Dr. Van Allen, who was given the first ARS research award for his contribution to scientific research suggested that federal support of \$100 million a year for the next few years would be a "generous" beginning effort.

The ARS award was presented by Donald Douglas Jr., president of Douglas Aircraft, sponsor of the award.

(See p. 14 for a full report on the New York meeting.)

### NASA Salary Troubles

The Administration soon will order a study of actions needed to prevent the loss to industry of skilled government scientists.

The study is a result of Vice President Lyndon Johnson's recent trip to West Coast space facilities.

The study will be made by the National Space Council, a special panel, or the Civil Service Commission.

One top White House space advisor favors setting up a non-profit corporation which would hire top scientists for employment on NASA projects. The corporation would not be restricted by government pay scales.

NASA officials report, however, that they have no plans to set up such a corporation.

The corporation would require congressional approval.

(See editorial, p. 58)

### Military Procurement Changes

Substantial changes in military procurement are on the way. There will be an increase in the level of fees to be permitted on incentive type contracts and an attractive improvement in selection of contract types.

Pentagon officials still are working out the details. But one anticipated change calls for elimination of the present Armed Services Procurement Regulation (ASPR) limit on fees on incentive contracts. Contracting officers also are to be encouraged to use more incentive and fewer cost-plus fixed-fee (CPFF) contracts.

Also expected is a new restriction on the authority of military contracting officers to award negotiated contracts on a non-competitive basis. At present, ASPR's provide that lack of adequate specifications can be considered a reason for using negotiation instead of advertised procurement. These situations usually result in sole-source buys. But application of the exception is limited to procurement of \$50,000 unless approved by higher officials.

An upcoming revision is expected to lower this ceiling to \$10,000. There probably will be exceptions to cover components vital to the functioning of an end item that ordinarily would be purchased from a sole-source contractor.

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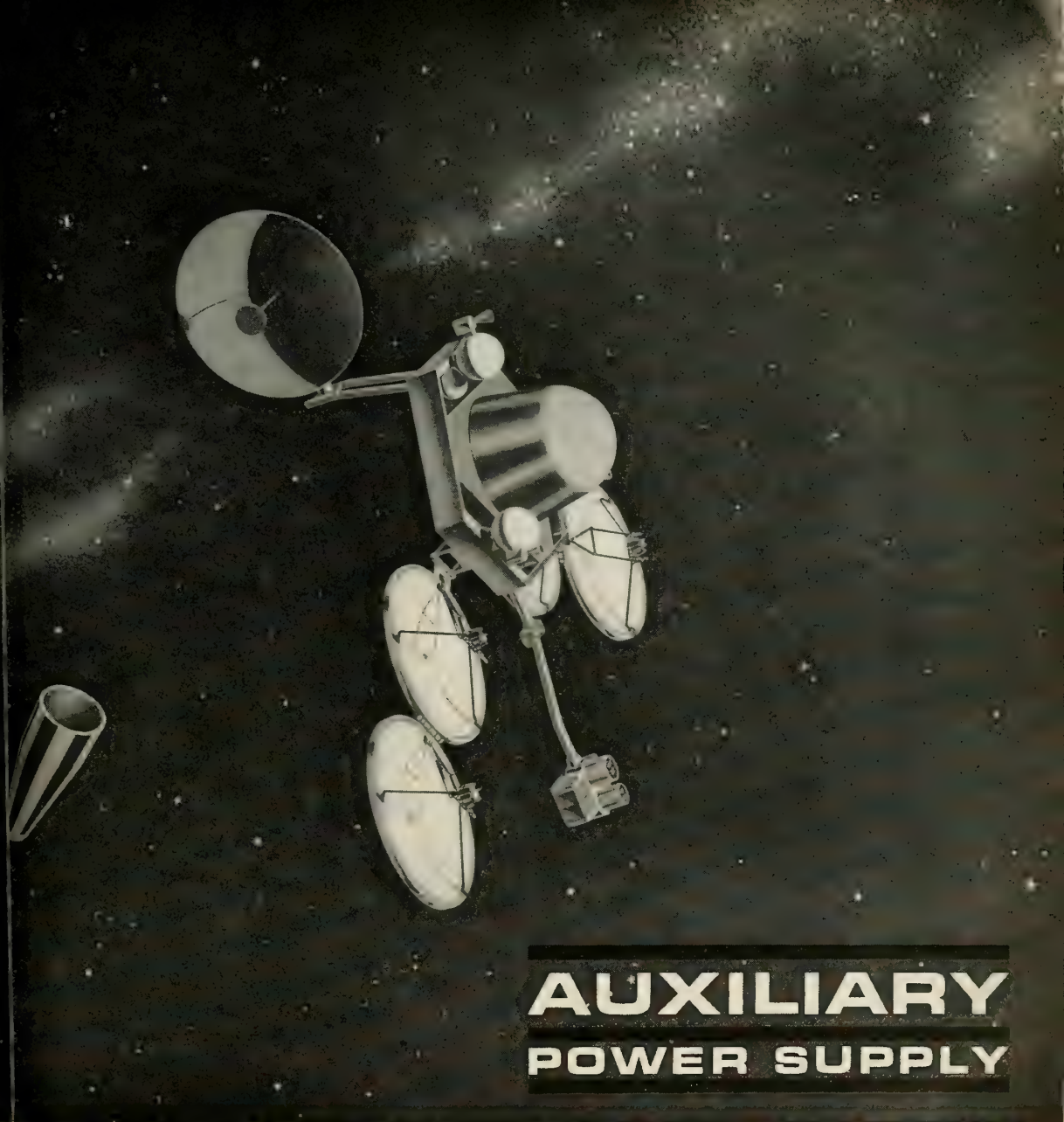
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## AUXILIARY POWER SUPPLY

Direct conversion of heat to electricity offers the solution to the problems of auxiliary power in space.

New techniques of space charge neutralization are being developed at Ford Instrument Company under U.S. Air Force, U.S. Navy and company sponsored studies. This work offers the opportunity to obtain significant power densities with wide spaced plasma power diodes at cathode temperatures around 1200°C. Application studies currently being undertaken involve chemical, solar and nuclear heat sources.1.a



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CREATIVE TEAM OF SCIENTIFIC, ENGINEERING AND PRODUCTION TALENT

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# Largest Industry Exhibit— Space Flight Report to Nation

*Highlights are reported advances in propulsion,  
materials, nucleonics, transportation and vehicle designing*

NEW YORK—Down-to-earth technical advances in propulsion and materials took the spotlight away from more exotic space projects at last week's huge American Rocket Society meeting here.

With more than 15,000 scientists and engineers attending the sessions which concluded at New York City's Coliseum yesterday, the "Space Flight Report to the Nation" was the largest aerospace meeting ever held.

Fifty-three technical sessions ranged across the entire spectrum of aerospace activities. In addition, nearly 200 exciting industrial exhibits were housed in three floors of the Coliseum to show in the reality of hardware some of the concepts discussed by the speakers.

It was, without question, one of the most fantastic displays ever seen.

While moon-crawlers and space-suits caught the attention of the general press and the fancy of the public, it was in more mundane fields of technology that real advances were disclosed.

• **Concrete progress**—These were some of the technical highlights:

—Thiokol Chemical Corp. in a sharp departure from earlier philosophy, disclosed it is investigating a segmented approach to 160-in. solid boosters as part of the feasibility program.

—Hercules Powder unveiled an on-site filament-winding concept with unlimited size capacity, based on current state-of-the-art in solid propellants and glass fabrication.

—New beryllium structures—such as foam-filled panels and strong, lightweight structural shapes for space work—were revealed for the first time.

—Boron filaments for winding motor cases and for other high-stress work

were described as competitive with fiberglass.

—Nuclear power supplies with one-fourth the specific weight of high-power SNAP units were predicted for 1967.

—Potential capabilities of the Air Force *Titan II* ICBM as a booster in U.S. space missions were revealed when Aerojet-General Corp. spelled out its third-stage design.

—A vapor-cooled insulation system for a hypersonic glide vehicle was said to provide better thermal protection and significant savings in weight.

—A booster recovery program using parachutes and LSD's was strongly endorsed as a result of salt-water immersion tests conducted by NASA's Marshall Center.

—After analysis of all modes of booster transport, The Martin Co. reported that the optimum system would be movement of the very large vehicles by air.

• **Segmented rockets at Thiokol**—Segmented 160-in.-diameter solid boosters are under investigation as part of a three-pronged effort at Thiokol Chemical Corp.

## ARS Coverage

THIS REPORT on technical developments at the American Rocket Society meeting in New York was compiled by a MISSILES AND ROCKETS editorial team under the direction of Engineering Editor William Beller. The team included associate editors Frank McGuire, John Judge and James Trainor. Coverage of electronic and space medicine activities at the ARS show will appear in next week's issue.

A company spokesman says an integral part of the program involves adapting "existing production techniques to transportation and handling equipment for in-plant processing and shipping complete units to launching sites."

The other two areas are intended to develop a cluster of four one-piece engines, each about 240-in. in diameter and producing a thrust of five-million pounds, and to check out design of a 28-ft.-diameter engine capable of some 20 million lbs. of thrust.

Either segmented or monolithic engines of the required size and thrust for lunar missions can be available for testing within 14 to 24 months.

Thiokol experts say the degree of scale-up represented by the three preliminary designs does not present as great a technological challenge as the jump from the *Falcon* to first-stage *Minuteman*.

Transportation studies involving engine segments were made with a dimensional model at the company's Wasatch Division. Necessary shipping routes and methods for the larger engines were also conducted.

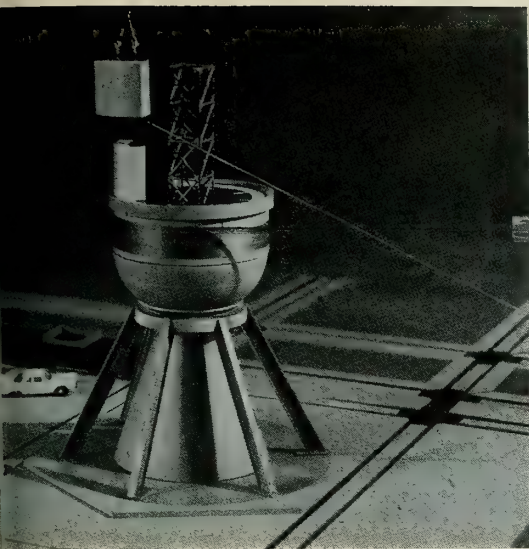
• **Ad Astra Per**—Hercules Powder unveiled a solid booster concept consisting of stacked pie-shaped segments filament-wound on-site and reaching any desired height. One typical vehicle would use 10 million lbs. of propellant in 100 pieces.

The booster would be 150 ft. high and 38 ft. wide, with a thrust of 20 million lbs. for two minutes. Another typical rocket 30 ft. across and 130 ft. high, with 13 million lbs. of thrust would have a mass fraction of 0.9.

Its sectors are side-inhibited, and

missiles and rockets, October 16, 1966





PROPELLANT SEGMENTS of huge Hercules booster are positioned within an adapter band on nozzle before wrapping.

complete section burns radially. Additional segments add surface but do not alter the shape of the ballistic trace.

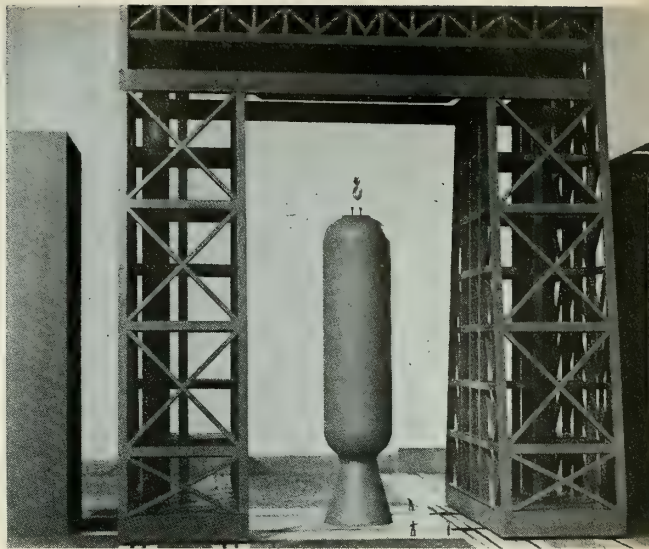
In a 72-sector rocket, a crack running the full distance from star point to star point, with both sides exposed and the pressure level, would add less than 1.5% to the pressure level.

In the vertical assembly, a center support structure is used for locating and indexing propellant sections. The center can be fabricated in two ways, by filament winding or by integral casting with asbestos/phenolic panels. The unit must be able to support the weight of the finished rocket.

One major consideration, says Hercules experts, is the behavior of the propellant sections. Analysis shows that the most severe consequences are shear deflection and radial growth of the outer segments. Shear deflection is dependent on propellant overhang. If the unsupported part is 3 ft. of the total point, deflection amounts to about 1 in. But if 6 ft. overhang with no taper, the deflection is 10 in. Compressive loading is prevented by inhibitors and the original circumferential windings. The propellant is essentially contained before the load is applied.

Ignition is best accomplished with a small rocket in the forward head. A nozzle design is best—one from which gas is ejected in many directions. Calculations have shown that a 5-million-lb. rocket can be ignited with 2500 lb. of propellant.

Size is completely arbitrary, says Hercules, and the entire concept is based on the current state of the art. The firm exhibited a working model of the filament winding machine.



MASSIVE BOOSTER is filament-wound on launch pads in Hercules concept. Assembly building separates and moves away.

• **Liquid spurt**—A third-stage propulsion system for use with *Titan II*, when that ICBM is openly tagged for a space-booster role, was revealed by Aerojet-General Corp.

The company said the vehicle, designated *Hylas-Star*, could boost over 12,000 lbs. to escape velocity. The pressure-fed engine, using liquid hydrogen and oxygen to develop 20,000 lbs. thrust, would operate at low chamber pressures on the order of 100-200 psi.

Burning time would be dependent on tankage design, but estimates place this between 200 and 300 seconds, with a possible requirement for 500 seconds.

Thus far, the *Hylas-Star* is an Aerojet-funded project, and no significant amount of hardware fabrication has been carried out. It is planned as a simple, low-cost unit designed specifically for *Titan II*, but Air Force officials have stated that the big ICBM will be used for space missions with or without a third stage.

With a powerful third stage on it, however, *Titan II* could duplicate the Soviet Union's Venus probe, which sent about 14,000 lbs. toward that planet. Aerojet officials feel that the Soviet shot had less sophistication than *Titan II* incorporates, and the U.S. missile thus could make a Venus trajectory with lesser thrust.

*Agona-B* could reportedly put 8000 lbs. in an escape trajectory, and the proposed *Draco* stage of STL/Bell (M/R, Oct. 2, p. 24) could place 3000 lbs. in a 24-hour orbit—the *Advent* communications satellite mission. In addition, *Centaur* and *Able-Star* have been considered as third stages.

Both Aerojet and The Martin Com-

pany, prime contractors on *Titan II*, feel the missile will far exceed the success record of its predecessor when flight-testing begins later this year or early next year.

• **Nova nuggets**—In addition to unveiling its *Hylas-Star* stage for *Titan II*, Aerojet described its candidate for upper-stage use on *Nova*.

This LOX/hydrogen system would be single-barreled in its basic configuration, and develop 1-1.5-million-lbs. thrust. Its pump-fed nature is conventional, and Aerojet sees no ignition problems with the propellant mixture, even when a double or multiple-barreled stage is designed. NASA is believed to be interested in the vehicle, which would probably have a nuclear final stage.

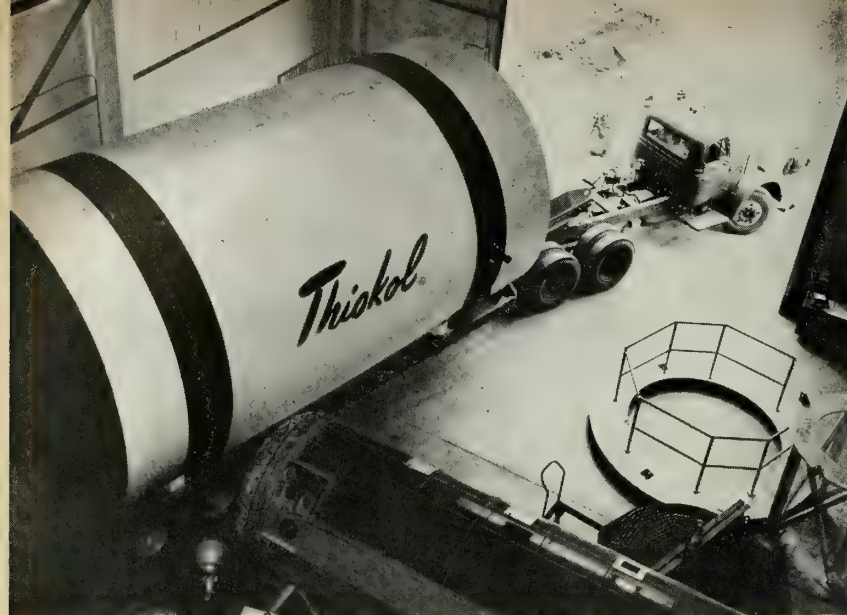
In the first-stage field, Aerojet indicated considerable interest in a single-barreled, 6-10-million-lbs.-thrust liquid rocket engine using either storable fuels or hydrogen/oxygen. This engine, the next step beyond the Rocketdyne F-1, is now under study at Aerojet's Sacramento plant.

• **New beryllium structures**—Beryllium, the metal with the highest strength-weight ratio, showed up in new forms when The Beryllium Corp. displayed foam-filled panels made of the metal.

These panels comprise two beryllium sheets sandwiching a beryllium-oxide foam center. The assembly forms a lightweight design with good heat-resistant properties.

The company told M/R that production has advanced to the point that some standard-size panels are available off-the-shelf. They have a melting point over 3400°F, weight of 28 lb./cu. in.,





*FULL-SCALE MOCKUP shows how Thiokol's 160-in. booster segments can be handled by currently available road equipment—both in-plant and cross-country.*

and compressive strength of over 800 psi.

The company also staged what is perhaps the first public display of beryllium in standard structural shapes such as angles and channels. Missile and spacecraft structural uses are foreseen.

In an extension of Beryllium Corp.'s interests, the company announced that it is developing pyrolytic-graphite shapes for re-entry. A pyrolytic-graphite probe is 6 in. in diameter and 0.2 in. thick, with a 4-in. skirt, was exhibited. The company says it has made 14-in.-diameter hemispheres of the material, and cone and nozzle shapes up to 20 in.

- **Stressed boron**—A potential competitor to fiberglass as a structural material was suggested by Texaco Experiment, Inc., Richmond. Under an Air Force contract, the company has prepared filaments of elemental boron having specific strengths up to 10.8 million in. and specific moduli up to 860 million in. The company is developing a continuous process for turning out these filaments and expects that they will be used in rocket cases, spacecraft and deep-diving submarines.

A Texaco spokesman told M/R that if the high-temperature properties of boron are retained when it is used as a filament winding, hotter rockets can be designed with correspondingly increased performance. Boron filaments are said to have the same strength as fiberglass—but four to five times its modulus of elasticity.

The company also has a potential semiconductor material that could be a boon to designers needing circuits able to operate in elevated temperatures.

Contained in a small glass vial at the Texaco Experiment display, the material was described as a crystal of elemental boron. About 2 cm long and 1 to 2 mm in diameter, it is representative of the company's recent work in producing the first sizable single crystal of the material.

Dr. Lloyd E. Line, head of exploratory research for the company, told M/R that early tests show the boron crystal retaining its electrical properties at temperatures higher than do semiconductor materials such as silicon and germanium. He added that a better indication of the semiconductor properties of boron would be available after a few more months of experimenting.

- **Space power**—Pressing its proposal for multi-KW fuel cells as an auxiliary power source for space vehicles, General Electric prominently displayed in schematic form a system that has direct application to *Apollo*. Based on the ion-exchange membrane fuel cell—which GE announced in 1959—the power system is fueled by cryogenic hydrogen and oxygen.

The schematic shows the oxygen being used as both an oxidizer and a coolant, with the major cooling job being done by a liquid system connected to an external radiator.

It is known that GE is currently building an ion-exchange membrane fuel cell for testing in a 30-day satellite.

A 50-watt power range is being planned for the first fuel-cell test capsule, which will probably be launched in 1962.

The Martin Co. disclosed that it is doing research on an auxiliary nuclear

power system able to generate electrical power in the SNAP-8 range at about one-third SNAP's specific weight.

Called "DCR-60," the unit is designed to generate 60-KW of electrical energy for space applications. The system is potentially lightweight because it converts the nuclear reactor heat through thermionic techniques directly to electricity.

Martin believes the unit will be used as a power source in space laboratories, global communications satellites and electrical propulsion engines.

Martin project engineer Richard Strzelecki told M/R that a prototype of the DCR-60 could be built by 1967. He estimated its specific weight at 15.3 lb. per electrical kilowatt, which includes all components except shielding structure. This contrasts with the estimated specific weights under the same conditions for SNAP-8—which for a 30-KW system is 50 lb./KW, and for a 60-KW system, over 40 lb./KW.

Strzelecki says DCR-60 could be extrapolated to 100 KW without a significant increase in overall specific weight. He stated that whatever increase occurred would result only for an increase in radiator weight, because the reactor and generator would remain the same size.

The DCR-60 is a company-funded project which also includes basic development of a 300-KW thermionic system, expected to have a specific weight between six and seven lb./KW.

- **Dyna-Soar cooling**—A water-cooled system which would provide thermal protection to hypersonic vehicles during re-entry—while at the same time reducing the overall weight of the thermal shield—was described by William D. Allingham of The Boeing Co.

Citing the limited heat-absorbing capacity of metal heat sinks during 30-minute aerodynamic heating re-entry periods, Allingham described a passive system in which a water-saturated material absorbs the heats and vents the steam produced to the atmosphere through outer insulation.

The system which could have application to *Dyna-Soar* consists of an outer re-radiating skin, a space vented to the atmosphere, a perforated radiation shield, a layer of porous insulation and a heat sink consisting of water-saturated ceramic fiber wick.

During re-entry, the water in the wick is converted to steam and vented outward, cooling the outer skin. As flowing steam cools the insulation, it becomes superheated, thus increasing the energy absorbed per unit mass of coolant.

*(Continued on page 48)*



Week-long orbit by '63 . . .

# New Program May Fill Pre-Apollo Gap

by Hal Taylor

NASA is considering a new manned space flight program to fill the gap between Projects *Mercury* and *Apollo*.

The program, proposed by NASA's Space Task Group, is designed to put an American astronaut into orbit around the earth for as long as one week sometime in late 1963.

Its prime hardware will be an enlarged version of the *Mercury* capsule. It will weigh in the neighborhood of 10,000 to 7500 lbs., far heavier than the 6000-lb. capsule now being used in the U.S. manned space flight series.

The bigger capsule will probably necessitate the use of a bigger booster than the *Mercury* program's *Atlas D* launch vehicle. There are persistent reports that the Air Force's *Titan II* ballistic missile will be tapped for the job.

In another manned space flight development, it was also learned that the space agency is pushing ahead with plans to modify current *Mercury* capsules to enable the U.S. to duplicate late last year the recent 18-orbit flight of Soviet Cosmonaut Titov.

The changes are the result of a study made under a \$90,000 contract by McDonnell Aircraft Corp., prime contractor for the *Mercury* capsule. The changes include the removal of certain auxiliary equipment from within the spacecraft in order to provide sufficient room to house a life support system capable of sustaining a U.S. astronaut for the 24-hour flight.

The removed equipment will be placed in the "adapter" which connects the capsule to the booster and will be jettisoned during the flight.

Both projects are the result of a NASA desire to bridge the "technological gap" between the *Mercury* and *Apollo* programs. *Mercury* is currently scheduled to terminate in mid-1962 with a series of three-orbit manned flights. A manned *Apollo* flight will not be flown until 1965.

Approval of the life support modifications for the 24-hour orbital flight is certain. Space Task group is already working on the mission and work should be completed in the near future.

• **Decision soon**—Top space agency officials also report that the "new program" is under active consideration by Administrator James E. Webb and

other high officials. A final decision is due within a month.

An official said there are several proposals for an advanced program under consideration, but that if one is given the go-ahead, it is likely to be the one which involves an enlargement of the *Mercury* capsule, its technology and equipment.

Reports by Russian scientists at the International Astronautical Congress meeting concerning the alleged "seasickness" of Titov during his flight have provided added incentive to supporters of the U.S. advanced program.

Certain U.S. space medicine experts said the "seasickness" might mean that there are real roadblocks in the way of a manned flight to the moon and back.

Space agency officials refused to comment officially on the subject. They point out that nothing is known as to

Titov's physical condition before undertaking the flight. There is also the possibility that the conditions which produced the seasickness in Titov might not produce the same effect in another astronaut.

No true assessment can be made, NASA believes, until the U.S. puts a man into space for long periods of time.

This is just what the advanced program would do, its adherents contend.

It would permit the U.S. to orbit one—and perhaps two—astronauts for a period of five to seven days, just about the length of a manned moon flight. The long orbital flights would permit the U.S. to test the effects of long periods of zero gravity on man, without waiting for the development of the technology and materials needed for a moon spacecraft capable of returning to the earth from escape velocity. ■

## First Saturn Launch Is Fateful Step

THE U.S. SPACE program reaches a significant milestone late this week with the first attempt to launch the *Saturn C-1* booster—America's and perhaps the world's largest space launch vehicle.

If successful, it will be a big stride forward for the U.S. space program and this country's chances of beating the Russians to the moon. Technical difficulties with one of the eight H-1 engines of the first stage delayed a scheduled launch earlier in the month. Blastoff is now scheduled for Oct. 20.

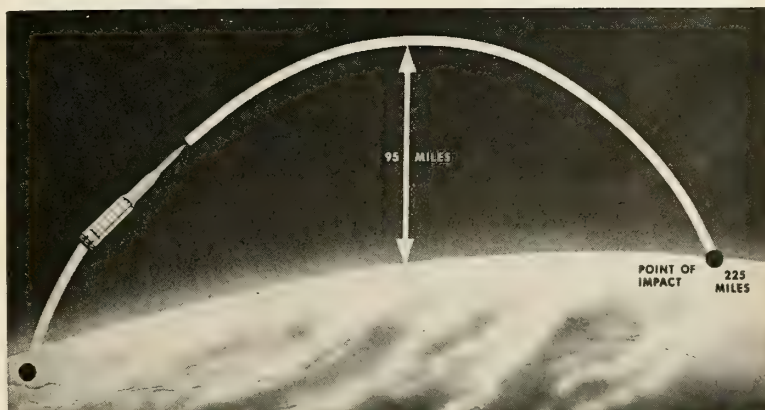
NASA announced that the main purpose of the first flight is to test the

propulsion system of the booster, verify aerodynamic and structural design of the entire vehicle, and prove the design concept and function of the ground support and launching equipment.

For the first launch, only the first stage will be live. It will propel two inert upper stages which will be ballasted with water to simulate the weight of the live stages.

The first flight will have a short trajectory of 225 statute miles and a peak altitude of 95 miles. Duration of the flight will be eight minutes and the top velocity will be 3700 miles per hour.

(Continued on page 47)



NEWLY RELEASED drawing shows planned flight path of first Saturn C-1 launch.



## *Arma navigates new routes*

Navigating with cross-staff and primitive compass, Prince Henry's Portuguese pilots took more than 80 years to find a route around Africa and reach India. The Spaniards took another 20 years to cross the Atlantic and reach the shores of Florida.

Today, missile-borne inertial guidance can navigate such distances in a matter of minutes and pin-point targets nearly half-way around the world. Other advantages of inertial navigation are immunity

to outside interference, all-weather capability, salvo firing, and a minimum of ground equipment.

Arma, designer of America's first inertial guidance of intercontinental range accuracy, has these systems in full production with on-schedule deliveries. Although specified for the Atlas missile, the Arma system is equally adaptable to other

aerospace programs and space exploration projects.

At Arma, research programs currently are exploring smaller, supersensitive devices for future generations of missile and space guidance systems. Arma, a division of American Bosch Arma Corporation, Garden City, New York. . . . The future is our business.

**AMERICAN BOSCH ARMA CORPORATION**



# Sergeant to Give Army Tactical Boost

Long-awaited inertially guided system, operational '62, will be far more mobile than old Corporal

by James Trainor

**SERGEANT**—the Army's mobile replacement for the *Corporal* tactical missile—will provide the army or corps commander with at least an order-of-magnitude improvement in system effectiveness over its lower-ranking predecessor.

The missile is well along in production at Sperry-Utah, prime for the system, and scheduled to be operational next year. It successfully completed its R&D test-firing phase with a series of shots ending at White Sands Missile Range, N.M., two weeks ago. The Army has more flight tests of production models.

• **The difference**—A quick comparison of the two systems gives clear evidence of *Sergeant's* superiority over the more complicated *Corporal*. The older weapon uses liquid, hypergolic propellant, while *Sergeant* employs a stable, long-shelf-life solid which eliminates the time-consuming, dangerous fueling operation and its demands for specially trained personnel, protective clothing and vehicles.

Because it was developed during the infancy of missile technology, the *Corporal* is saddled with a radio command guidance system which requires heavy, complex ground support equipment. By contrast, *Sergeant* is equipped with inertial guidance and needs only the checkout panels used to insert firing data and to test and monitor the system status.

Probably the greatest asset of the new system, however, is its extreme mobility. Using only four vehicles, *Sergeant* closely approaches the Army's



**SERGEANT USED IN FINAL** shot of R&D test-firing series at White Sands Missile Range, N.M., recently. Sperry-Utah and Army personnel carried out the launch.

"shoot and scoot" philosophy. In addition, it is air-transportable in Phase II in airborne operations by C-130 type aircraft.

The overall reduction in both the size and the amount of equipment has made the *Sergeant* not only more mobile but also more reliable. The maintenance concept—based on plug-in replacement of assemblies and subassemblies—has also contributed significantly to the flexibility and responsiveness of the system.

• **How it began**—Even while the *Corporal* was being developed back in 1950, the Army realized the need for a second-generation system to replace it. However, the project languished until, in 1953, Jet Propulsion Laboratory submitted to the Army Ordnance Corps the preliminary design of a solid-propellant missile.

It was not until January, 1955, however, that the Army approved JPL's proposal and gave it an R&D contract for the system which was to be developed under the technical supervision of the Army Rocket and Guided Missile Agency—at that time Redstone Arsenal.

To preclude time-consuming delays in changing from an R&D contractor to a production contractor, the Army selected the Sperry Gyroscope Co. to work with JPL on missile development. When the Cal Tech organization was transferred to NASA on July 1, 1960, Sperry assumed responsibility for the R&D program. The final management change came a month later, when the Army made the Army Ballistic Missile Agency responsible for technical supervision of the *Sergeant* project, replacing ARGMA.

• **Four sections**—The 34½-ft. 31-in.-diameter missile is broken down into four basic sections: Warhead, Guidance, Motor, and Control Surface. All of the sections are transported in individual containers built in such a way that missile components can be checked out without removing the missile sections from or even opening, the container.

After checkout at the launch site, the boom on the launching station is used to mate the sections; electrical connections between the warhead and guidance sections are automatically made through the use of ram-home fittings. Attached last, the interchangeable fin assemblies slide into place over shoe and slot brackets.

After the firing data is inserted into the firing-set computer, fed from there into the missile and rechecked on a go-no-go indicator panel, the missile is elevated to five degrees from the horizontal and slewed to the proper firing

azimuth. Then it is elevated to 75 degrees, the countdown is automatically completed and the missile is fired. A precise theodolite determines the firing azimuth by autocollimation.

• **And away she goes**—In flight, the azimuth, roll and range are controlled by control surfaces at low altitudes, jet vanes in the thinner atmosphere, and drag brakes.

Unlike the liquid-fueled *Corporal*, the 50,000-lb.-thrust *Sergeant* motor cannot be cut off by a valve in the propellant stream. Therefore, after various methods of cutting off the motor were studied, drag brakes—located at the rear of the guidance section—were installed to control the velocity and, therefore, the range of the missile. Development of this system caused some problems; however, according to project engineers, these have been satisfactorily solved.

Reportedly, the missile has the same range as *Corporal*—80-110 miles, and it carries a similar, approximately 1500-lb., conventional or nuclear payload. The missile weight at liftoff is set at around 10,000 lbs.

• **Ground support**—Designed to meet an estimated 30-minute reaction time, the *Sergeant* GSE has been designed for transport on standard Army trailers pulled by standard tractors. Other than the missile and the storage containers, the support equipment consists of the launching station, Organizational Maintenance Test Station (OMTS) and the Field Maintenance Test Station. All of the elements necessary to fire are contained in four tractor-trailer loads.

The launching station—the largest and heaviest piece of support equipment—mounts the erector-launcher, a gas turbine generator set, the azimuth orientation unit, an azimuth ring for slewing the missile, a blast deflector and leveling jacks.

When the unit enters a firing position, the launching station is uncoupled from the tractor and the gas turbine is started—reaching full speed in 30 seconds. The outriggers are emplaced, the circular aluminum blast shield dropped and, finally, the superstructure is raised and the boom extended.

The boom is used to lift the missile sections from their coffin-cover containers and assemble them. The missile is now ready for the final launch preparation described above.

The OMTS provides checkout and first and second-echelon maintenance to the firing unit in a service area adjacent to the launch site. Automatically self-checking, the test station determines if the missile sections are per-

forming properly. In the event of failure, the test stops and the fault isolated to a particular unit.

A jib-crane lifts the faulty section from its container to the maintenance area inside the van. There the defective assembly is replaced from the spare load carried on the vehicle.

Further to the rear, in an Ordnance direct support unit, is located the Field Maintenance Test Station (FMTS) which provides support to several *Sergeant* batteries. Capable of performing the same operations as the OMTS, the field maintenance station has the added capability of further isolating the fault to the subassembly level and repairing the assembly from its greater variety of tools and spares.

• **Tests cover all angles**—As early as 1958, the Army began a comprehensive environmental test program to insure that the *Sergeant* system would perform under all conditions of terrain and weather. That first four-week test with an experimental system at the Army's Yuma desert test station proved that the *Sergeant* would provide the mobility and ruggedness that was required. In addition, the system has undergone gruelling tests in the climatic chambers of Sperry's Utah plant.

Flight tests—initiated only one year after the development contract was approved—proved the feasibility of the *Sergeant* concept. Further flights in 1958-59 resulted in some redesign of the system, but again basically proved the soundness of the system approach.

Subsequent firings have progressively integrated the operational prototype support and maintenance equipment to insure system compatibility. The firings leading up to the successful final R&D firing included firings under blackout conditions, sustained rate of fire exercises and a mountaintop-to-plains firing to prove the accuracy of the fuzing and arming system even at wide variations of altitude between the target and launcher.

However, the flight testing has not ended. The Army plans to continue firing in order to verify the performance of the production missiles and to insure that they meet the rigid military characteristics set forth for the tactical system.

Once the Army is satisfied that *Sergeant* really outranks its veteran *Corporal*, the system will begin to replace *Corporal* units stationed in Europe at the United States. This changeover—scheduled to begin next year—promises to give the Army a mobile flexible atomic punch to back up its combat divisions.





A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

## NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

### TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

### THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to the long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth's cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

### CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation of meteorological satellites.

If you are a professional physicist, engineer, or mathematician and interested in participating in such challenging projects and stimulating team efforts, contact the Employment Manager, RCA Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.



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# Technical Countdown

## ASTRONAUTICS

### Apollo to Use Fuel Cells

Word from contractors working on *Apollo* proposals that NASA has told them the lunar spacecraft will use fuel cells for auxiliary power—despite opposing arguments from manufacturers of cryogenic units. Industry spokesmen also discount the possibility of using a regenerative system. A fuel-cell APU has not been flown as yet but NASA expects that before *Apollo* is ready, fuel-cell technology will have been tested in earth orbit. General Electric's Missile and Space Vehicle Dept., for one, has an Air Force contract pending for this.

## PROPULSION

### Engines in the West

Douglas Aircraft's Astropower subsidiary has test-fired successfully a 1500-lb.-thrust rocket engine which it has proposed as a vernier unit for *Apollo*. The engine uses hydrogen tetroxide and a mixed amine fuel.

The second Tory II A-1 power run in 10 days has been completed at the AEC's Nevada Test Site. The reactor was operated for about one minute at temperatures over 2000°F. Lawrence Radiation Lab scientists. Results are said to be satisfactory. The tests are part of an investigation of the potential of a nuclear ramjet for Project *Pluto*.

A flightweight, ablative-cooled thrust chamber assembly for liquid rockets has been test-fired by United Technology Corp. The unit has been continuously fired for 4.5 minutes with a 2200-lb.-thrust engine. Accumulated time with test firings has reached 7.2 minutes. The chamber eliminates the need for complex cooling tubes.

### 50-lb.-Thrust Variable Engine Developed

A hypergolic engine capable of a nominal 600-lb. thrust has been developed by Moog Servocontrols in cooperation with Marquardt and Naval Ordnance Test Station, China Lake, Calif. The new engine has been operated with pulsed firings at a repetition rate up to 130 cps. Pulse amplitude during these tests required that the engine vary  $\pm 300$  lbs. The engine can be operated in a proportional mode, and thrust can be varied in response to input signal from zero to maximum thrust levels. Suggested uses, says Moog, include cushioned landings, mid-course guidance, and maneuvering in space.

## ADVANCED MATERIALS

### Cryogenic Sampler Operational

An upper-atmosphere collecting system has been perfected by Aerolab. The cryogenic unit reduces the gases collected in volume by cooling to liquid hydrogen temperatures. In a recent 50-mile-high firing, the unit collected everything in 21,000 cu. ft. of air. The sample returns in the form of a frozen sludge and the system can contain high pressure as it warms up and the sample returns to its gaseous state.

### Sound Facility Completed

Goodyear Aircraft Corp. is exploring the destructive effects of sound in a new million-dollar facility. One noise-maker, a kind of a massive hi-fi set, can range through

frequencies from 37 to 10,000 cycles or higher in a single test. The unit has the ability to create noise of differing types and intensities, avoiding the penalties of a direct system. Time tests have run as long as 8 hours. In addition to two square chambers, Goodyear has a reverberant chamber to give its researchers multi-directional capabilities.

## SPACE MEDICINE

### BIOS Vital for Space Travel

NASA's *BIOS-1* capsule is slated for launch from PMR on Nov. 15. A follow-on program to *NERV*, the probe will have a 1015-n.-mi. downrange. (The former *NERV* facility will be used for *BIOS-1*, but it's hoped that the *Scout* site will be utilized for later launches.) *BIOS* (Biological Investigation of Space), will carry numerous animal test samples. The tests are considered vital because *NERV* results showed a neurospora mutation rate of over 30 times normal; further investigation is required to determine the reasons for this.

## ELECTRONICS

### Lunar Power Package Produced

A nuclear thermoelectric power system which uses the spontaneous decay of a radioisotope to produce heat and then electricity has been demonstrated by Westinghouse Aerospace. The system is designed to produce 50 to 60 watts for three months' life on the moon's surface. The heat transfer medium is liquid metal.

### Trend Toward Bigger Antennas Continues

Communications for planetary vehicles will be handled by JPL's Deep Space Instrumentation facility. It will also handle program support for *Apollo* and other manned lunar flights. Big future changes in this area are expected to be evolutionary, with accent upon increased ground transmitter power and larger antennas—both on the ground and on space vehicles. Vehicle power will probably remain about the same, with a maximum of 150 watts available in space probes and 10 watts for lunar-landing vehicles.

### S-27 Launch Due Next March

First Canadian-built satellite will be launched from the new *Thor* pad at Vandenberg AFB in March, 1962. This will be the *S-27*, a swept-frequency top-side sounder which will be used to study electron density in the atmosphere at altitudes between 300-1000 kilometers. The satellite will measure 42 in. dia. by 34 in. high. Weighing 275 lbs., it will be put into 625-n.-mi. circular orbit. Signals transmitted from the satellite will be received and re-transmitted back. Time delay measurements will be used to determine electron density.

### No Rebound 'Til '63

Project *Rebound* is slated for launch from Pt. Arguello in the second half of 1963. It will consist of three containers and three passive communications balloons boosted by *Atlas-Agena-B* into an elliptical orbit. Containers for balloons will be tracked for about 20 hours by ground stations, in order to adjust preset nominal timers which will open containers and place each balloon into orbit at the proper time with a 120-degree spacing.

# Air Bearings Enhance Gyro Testing

*Fluid-bearing suspension of turntables has brought order-of-magnitude range increase*

by Goddard C. Parsons and John A. O'Shea, Sr.\*

PRECISE PERFORMANCE evaluation of inertial guidance systems and their components has been limited in the past by the operating characteristics of the test equipment itself.

In particular, the use of mechanical anti-friction bearings in rotary test turntables has seriously handicapped determination of minimum residual drift rates of integrating type gyroscopes.

Recent developments in air-bearing suspension techniques, Dunn Engineering Corp. engineers believe, now make it possible to extend test-table range capability by an order of magnitude.

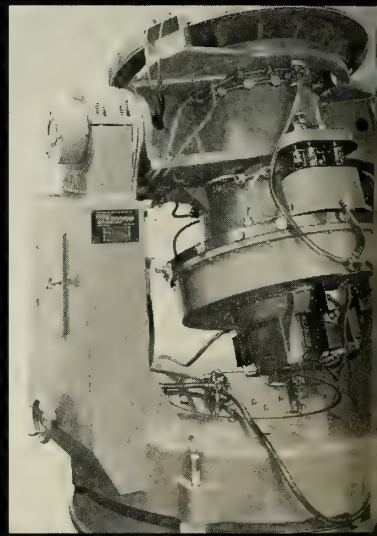
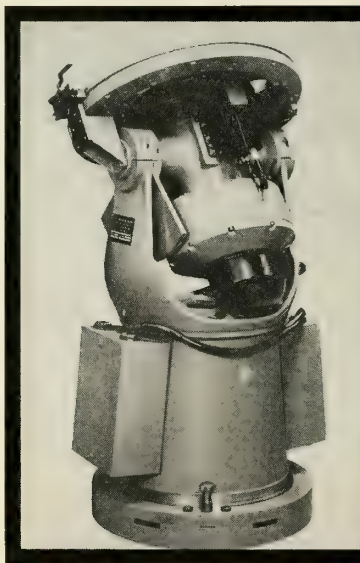
The advent of inertial-grade gyros made it necessary to design and build specialized test instruments capable of accurately measuring minute, non-compensatable residual drift rates. Residual drift is the prime measure of gyro quality and, as such, depends directly upon the degree to which the effects of gimbal friction and mass unbalance can be eliminated.

When friction is not a limiting factor, gyro performance is limited by mass unbalance.

The development during World War II of the floated rate-integrated gyro radically advanced the reduction of gimbal friction. As further refinements in manufacturing techniques were made, the need for more precise test equipment became increasingly apparent. As in all areas of measurement, the criterion for satisfactory instrument design is that the test gear performance be at least an order of magnitude better than that of the test specimen.

Of the several gyro test methods developed for measuring gyro drift rates, the most commonly accepted one was

\*Mr. Parsons is manager, Mr. O'Shea a mechanical design engineer, in the Inertial Products Dept. of Dunn Engineering Corp., Cambridge, Mass.



that employing the servo-test turntable. This instrument is a tiltable, single-axis table on which is mounted the test specimen. It is supported by anti-friction bearings and servo-driven from the gyro-output signal.

In this method of testing, the table is slaved to the specimen by means of the closed-loop servo system. Therefore, it becomes evident that the faithfulness with which the table follows the gyro is dependent upon the quality or performance characteristics of the turntable itself. Of major concern is friction inherent in the axis-support bearings.

Advancement in table design has centered around attempts to minimize friction or, more importantly frictional uncertainties in the bearings. Ten years ago machines fitted with conventional ball or roller bearings were adequate for measuring drift rates of  $0.1^\circ/\text{hour}$ ; today they are no longer suitable for

conveniently evaluating gyros below  $0.01^\circ/\text{hour}$  drift.

Successful application of fluid-bearing suspension to turntable design has made it possible to extend the range of performance by an order of magnitude. In particular, the use of air-gas-bearings makes practical the manufacture of high-performance test tables capable of testing not only the most up-to-date gyros but entire inertial platforms.

• **Metal bearing limitations**—Originally developed by the Instrumentation Laboratory of Massachusetts Institute of Technology, the widely-known type "D" table employs conventional roller or ball bearings to support the turntable axis. Modifications of the basic design have been produced by several manufacturers to meet the rapidly changing specifications caused by development of higher-performance gyros.



Improved gyro performance has imposed new and more stringent requirements on this type of test table.

The D-type table is seriously limited by static friction and by the variation in frictional torque caused by the mechanical bearings used to support the main turntable shaft. Frictional torque variation introduces "noise" into the servo loop, creating tracking errors which prevent the table from truly "following" the gyro. As a result, the test data usually represent a composite of both gyro and table performances.

• **Oil bearing an improvement**—To solve this problem, the Cambridge Engineering Laboratory of Dunn Engi-

of the fluid in the gaps. Using light viscosities and low rotational speeds, these shearing forces are low for the bearing sizes involved, and are constant at fixed speeds without exhibiting any "slipstick" characteristics present even with the best ball or roller bearings.

Non-uniform torques in fluid bearings, Dunn believes, are in general due to changing inertia or momentum forces in the fluid, and are much smaller than the random torques found in mechanical bearings.

In current applications, oil-bearing turntables are used primarily with complete navigational systems to check alignment of their inertial components

air are such that it is insensitive to variations in temperature. Conversely, small variations in oil temperature may produce substantial random effects on bearing behavior, even in a capillary-compensated oil-bearing design.

• **Early problems**—Initial experiments with air bearings included the investigation of designs using small grooves or recesses which create constant-pressure pockets. These help to increase the load-carrying capacity of the bearing. Such a design tended to self-oscillate or "flutter" except under certain restrictive conditions.

The so-called "air-hammer" phenomenon found in this type of bearing is due to an inherent instability caused by the pockets or recesses. When these self-oscillations were eliminated through design changes, the bearings were still only marginally damped.

The earlier investigations led to experimentation with inherently-compensated air bearings which avoided the use of recesses and were basically stable. Tests proved the design to be well suited to turntable applications. It has high stiffness and high relative stability; it is positively damped and not susceptible to the "air-hammer" experienced in earlier designs.

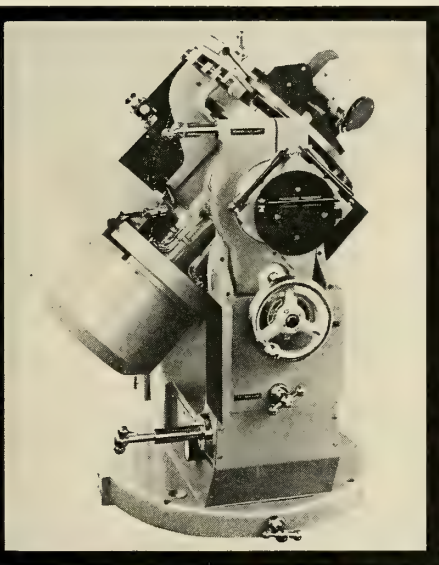
In its final configuration, the air bearing is similar to a conventional sleeve-type journal bearing with a thin film of air separating the fixed and rotating parts. The air itself is maintained by supplying air through upstream restriction or orifices so spaced and of such size as to provide controlled flow to the bearing gap.

By using a film of air to separate the movable and fixed bearing surface, Dunn developers found that "stiction" is avoided and viscous drag is negligible. The surfaces are kept clean or purged due to the gas flow through the bearing. The gas itself may be either air supplied from an ordinary shop air line (80-120 psi) or dry nitrogen from a high-pressure compressed-gas chamber.

• **Cost vs. performance**—The cost for air-bearing tables is comparable to oil-bearing types and is approximately 25% more than for roller or ball-bearing types. The demands of inertial-grade gyros now hitting the market—gyros with drift rates of the order of 0.001°/hour—can be met only with fluid bearings, however.

Bearings of traditional design will find less and less use because of the advantages of the air-bearing—low friction, maximum life due to the self-purging design, and reduced maintenance. ♦

EVOLUTION of gyro-st sidereal turntables is shown by these typical instruments developed by Dunn Engineering Corp. From left to right: standard type-D using roller or ball bearings for main table axis support (Model 800-D); fluid bearing (Model T818); and the new air-bearing servo/rate table (Model T900).



Engineering Corp. developed a compensated fluid bearing and incorporated it in a large equatorial platform (Model T818) which was introduced commercially in 1957.

The use of pressurized oil-bearings in this massive turntable made it possible to achieve precise orientations and frictionless rotation even with loads in excess of 500 lbs. By employing such bearings it was possible to eliminate the metal-to-metal contact of conventional bearings.

Also, the resulting accuracy of rotation was dependent only on the location of the mean surfaces. As a consequence, the fluid bearing, or film, served to average the geometry of bearing surfaces, resulting in precise location of its center or rotation.

Without metal-to-metal contact (even when not rotating), the main resistance to turning is that due to viscous shearing

and to observe gyro and platform drift characteristics.

• **Air bearing preferable**—New gyro testing requirements, necessitated by the development of still higher performance gyros, prompted Dunn to investigate the use of air-film bearings. This resulted in design and development of vastly improved turntables using gas-lubricated bearings.

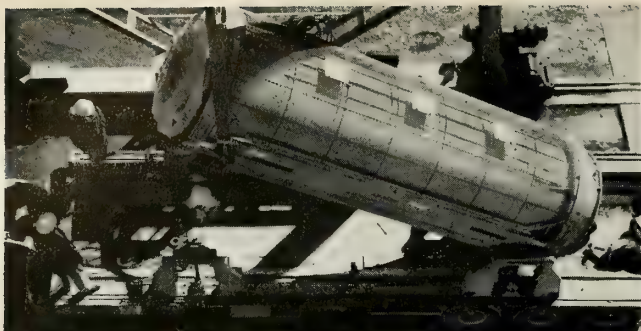
Air is preferable to oil, researchers believe, for several reasons:

1) There is no problem of fluid recirculation—air is exhausted into the atmosphere, continuously purging the bearing system.

2) Torques caused by non-uniform inertia or momentum-forces of the fluid are an order of magnitude less than for oil.

3) Viscous drag torques are much lower.

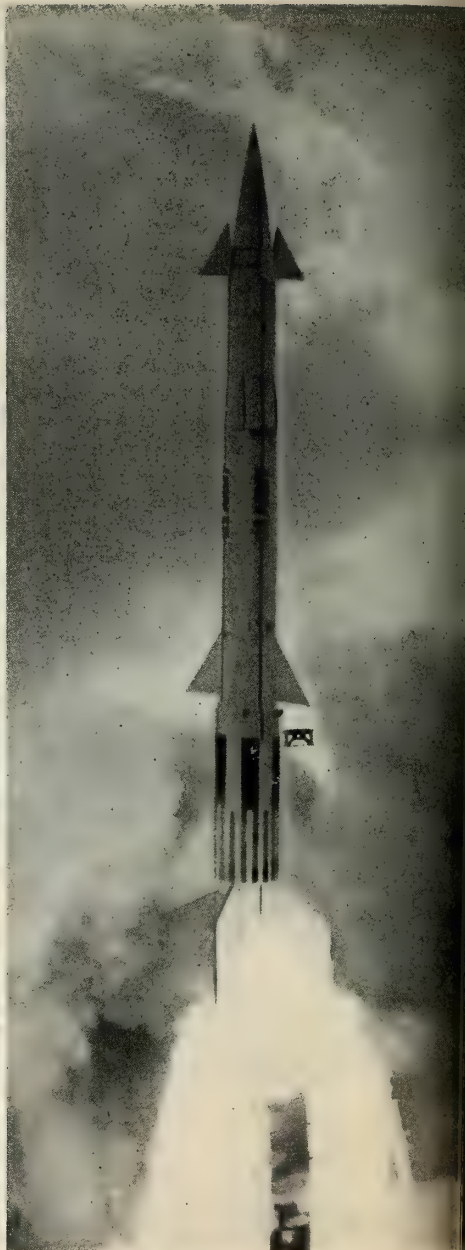
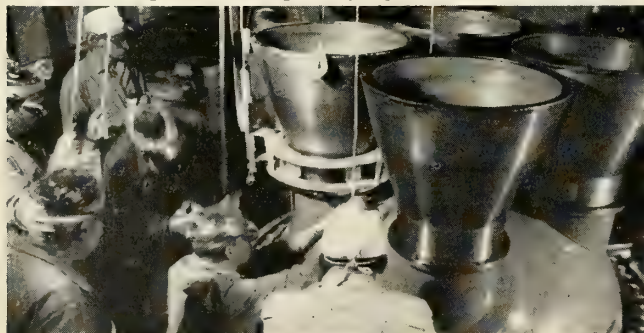
4) The dynamic characteristics of



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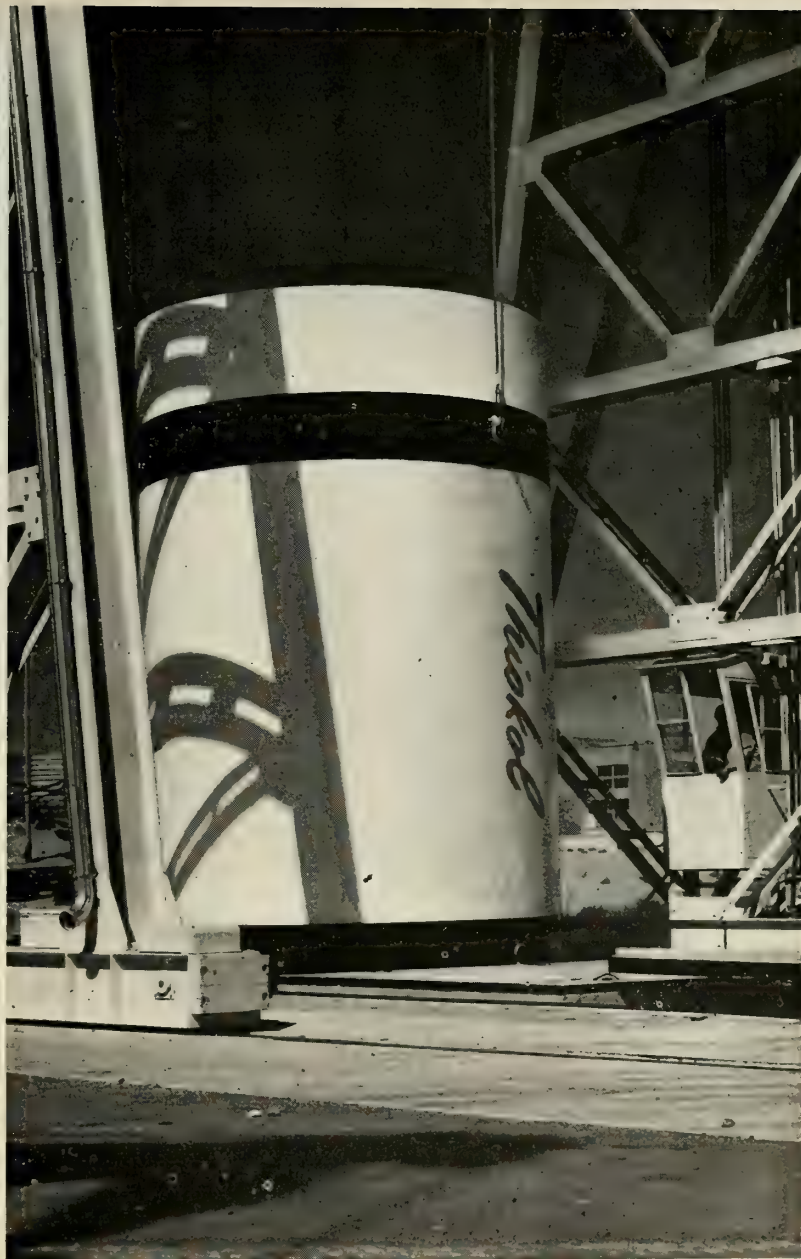
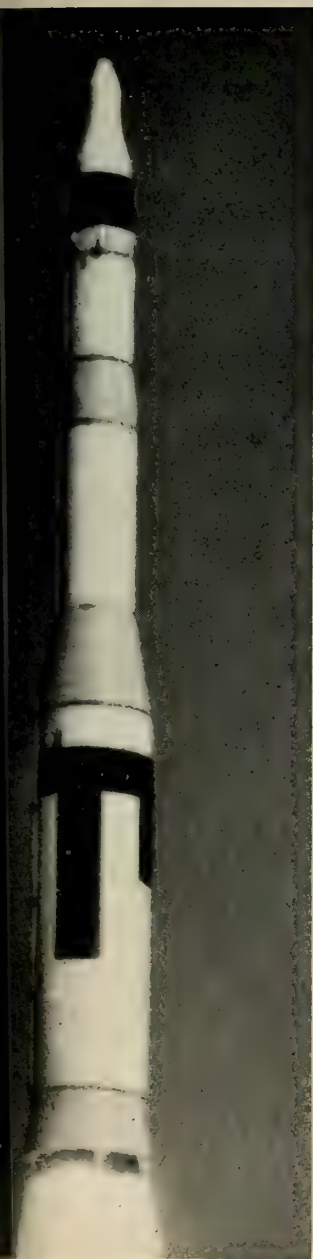
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# SYNCOM To Benefit From Ground Control

THE PROJECT SYNCOM communications satellite will feature a new simplified control system which NASA officials believe is a significant breakthrough in the art of controlling light spacecraft.

Prime advantage of the system is that it is controlled from the ground—removing a great deal of complex mechanism from the spacecraft itself.

The new system, designed by Hughes Aircraft, prime contractor for the project, was disclosed as NASA released preliminary details of the satellite's construction and operation.

The experimental active repeater communications satellite will be launched from Cape Canaveral late next year into a 22,300-mile orbit synchronous with the earth's rotation. A three-stage *Delta* vehicle will be the booster.

The satellite will be cylindrical—25 in. high, 28 in. in diameter—and weigh about 55 lbs., excluding an attached solid rocket motor which will be used to inject the spacecraft into its orbit.

For the first series of *SYNCOM* satellites, the orbit will not be stationary. Instead, the satellite will move in an elongated figure-eight pattern, 33 degrees north and south of the equator, over a given longitude above the Atlantic Ocean for its 24-hour period.

• **New controls**—To achieve this

orbit, properly orient the spacecraft, and maintain its attitude, Hughes developed the special control system.

The system employs two nitrogen jets. One is located on one end of the spacecraft about 12 in. to one side and thrusts parallel with the spin axis. This will be used to insure proper orientation for the spacecraft's estimated one-year life.

The other jet, located at the side of the cylinder, thrusts perpendicular to the spin axis. This will be used to provide precise adjustment of the orbit.

Solar sensing cells, located on the side of the cylinder provide information through telemetry, in real time, from which necessary adjustments in orbiting and orienting the satellite will be made by command from the ground.

It is this aspect of the system which NASA officials believe is most noteworthy. Almost all attitude control systems in earlier light satellites have been commanded from within the spacecraft, using heavy complex equipment.

The satellite will carry an array of 3960 solar cells to supply power and charge nickel-cadmium batteries which will power the satellite's instrumentation when it is not in the sunlight.

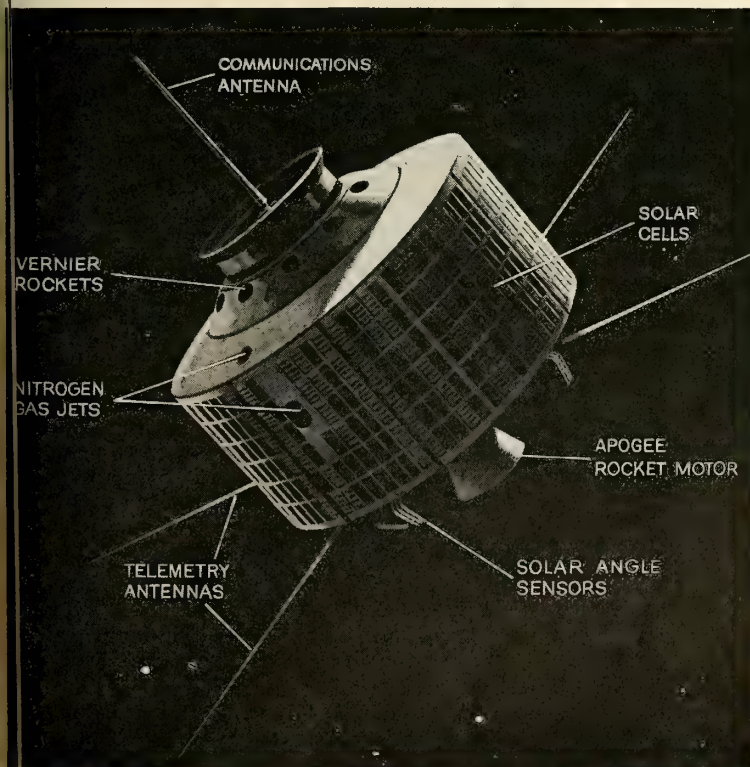
The system is designed to give the *SYNCOM* a "working" lifetime of one year, supplying 20 watts of power at 27.5 volts.

• **Redundancy**—There are duplicate telemetry and communication systems (including command systems).

The satellite will also have two antenna systems. A slotted-array antenna projecting from one end of the spacecraft will receive and transmit the telephone and telegraph communications. Telemetry will be transmitted by means of four whip antennas which are attached at the opposite end of the spacecraft, projecting outward 90 degrees apart in turnstile fashion.

Communications signals will be sent to the satellite on a frequency of 7500 mc. The signal will be amplified by a lightweight traveling wave tube and retransmitted to the ground on 1850 mc. Telemetry will be transmitted on 136 mc. In addition to relaying "real time" data on the attitude of the satellite, information will be telemetered relating to the solar cells, the communication systems, jet reaction system, and spacecraft temperature.

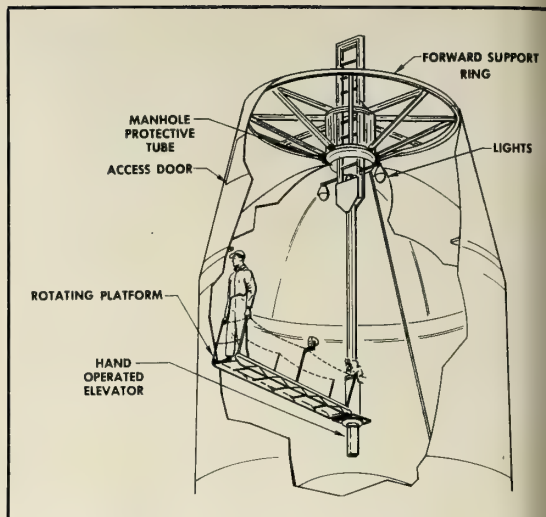
The satellite will be stabilized in orbit by spinning it like a gyroscope. Its spin axis will be perpendicular to the plane of the orbit and generally will be north-south in relation to the earth. Spinning, with the cylindrical part of the spacecraft always facing the earth, the satellite will transmit a circular beam with its edge always toward the earth. ❖



ARTIST'S CONCEPT of NASA communication satellite to be launched in 1962.



Saturn S-IV Transportation



Interior of Tank Access Kit

## support equipment

# Saturn S-IV Hints at Future Problem

**Too big for long-distance travel by rail or highway, S-IV will travel mainly by water; blimps, aircraft piggy-back have potential**

TRANSPORTATION and handling techniques are becoming a major influence in the design of massive U.S. rockets—thrust, mission and other more familiar criteria will soon take a back seat in comparison with the less glamorous tasks of packing and shipping.

For example, the *Saturn S-IV* stage will have transportation and support problems peculiar to itself—even though it is but one section of the complete *Saturn* vehicle.

H. L. Lambert of Douglas Aircraft Co. told members of the Society of Automotive Engineers in Los Angeles last week that the *S-IV* is too large for long-distance railroad or highway movement.

In addition, special transport equipment and packaging is necessary. Check-

out and handling apparatus will have to be built especially for the *S-IV*.

• **Piggy-back transit**—Because of its size, the stage cannot be carried in the cargo compartments of any existing aircraft. Its weight precludes the use of current helicopters. Lambert says blimps offer intriguing possibilities for long-range transport, and these will receive consideration in future designs involving larger vehicles.

A piggy-back method using a C-133 aircraft is under study. The stage, with aerodynamic fairings, could be mounted on top of the aircraft, and after some slight modifications in the form of vertical stabilizers, could easily operate off standard runways. This offers coast-to-coast capability.

Present plans call for moving the *S-IV* from the fabrication area at the Douglas Santa Monica plant to a Douglas facility at Sacramento for acceptance firing of the engines.

After completion of this phase, the vehicles will be shipped to the Atlantic Missile Range (AMR) for launching. One vehicle will go to Huntsville for dynamic testing prior to delivery at AMR.

The Sacramento trip will be handled with barges. The *S-IV* remains in its

transporter at all times except when actually placed in the launch or test stands. A total time of 3-4 days will be involved in this leg of the move.

• **Saturn by sea**—Studies have shown that water transportation offers the most readily available solution. In line with this, the *S-IV* will be placed aboard an ocean freighter in San Francisco Bay after the acceptance firing. Then it will be shipped via the Panama Canal to either Huntsville or AMR.

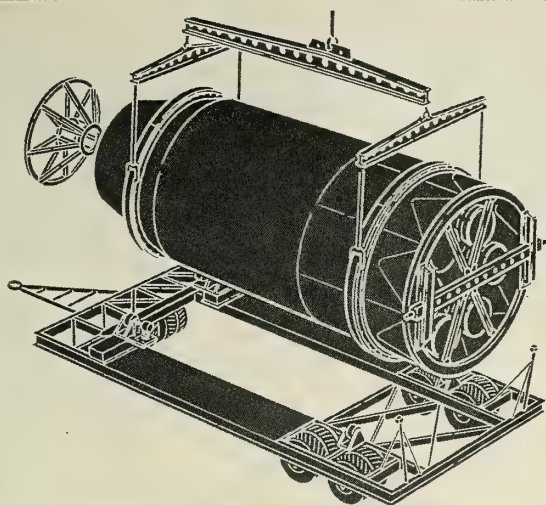
If the destination is Huntsville, the *S-IV* must be shifted to another barge at New Orleans for its 1470-mile, 14-day trip up the Mississippi, Ohio and Tennessee Rivers to the Marshall Space Flight Center.

An estimated 33 days will be required to move the stage from San Francisco to Huntsville, and 17 days to Port Canaveral from the West Coast city.

The transporter itself is a unique vehicle. It is a towable, fifth-wheel-type, approximately 46 ft. long, 22 ft. wide and 3 to 5 ft. high. With the stage aboard, it is capable of a speed of about 10 mph. Major structural members are expanded "I" beams. The unit weighs about 15,000 lbs.

The undercarriage consists of 8





Transport Handling Kit

## Transport, Handling

low-pressure, highly flexible, Goodyear Ultra Tires eliminating the need for ground suspension. The transporter can be dropped over a foot onto a concrete surface without exceeding the 2g load-restriction on the *S-IV* stage.

During transit, Lambert says, the vehicle will be covered with double-walled inflatable, neoprene-impregnated mon.

At the Sacramento test facility, ground support equipment includes the tank access kit, a diffuser access kit and the weighing system. The latter is a system designed for accurately weighing the stage before and after fuelling. A tension-weigh system is used, Lambert anticipates an accuracy within the  $\pm 0.5\%$  tolerance required.

The tank access unit provides servicing, repair and inspection capabilities. The crane-lowered assembly gives the inspector three degree of freedom. The platform section has a hand-operated winch for height adjustments and the platform extension is pivotable through a complete circle with certain tilting means to allow access to lower corners of the *S-IV*.

The Douglas *Saturn* stage is one of the first vehicles requiring engine tests in simulated space atmosphere. These

tests call for 31-ft. diffusers for each engine.

The diffuser is essentially a venturi that sustains its vacuum by engine exhaust flow. Using a steam ejector, air is evacuated from each diffuser until the desired altitude simulation is reached.

At the launch site, another ticklish handling problem arises. The light weight of the vehicle and its large projected area will cause the *S-IV* to sway at low wind velocities—if erected by a single hook. Guiding is a must, says Lambert. Studies are now under way to determine the extent of hoisting and mating problems during ground wind conditions.

Lambert says the *S-IV* is truly a baby when compared to future concepts in space vehicle boosters. As these pieces of hardware get larger, many "common" means of handling in use today will be out of the question.

"Transportation looms ominously as a specific problem that must be studied immediately." The point has already been reached where handling and transportation are imposing limitations on concept considerations in design of the vehicles themselves.

The development of large solids will make the problem even more acute. \*\*

## GE Re-entry Bodies Used As 'Poor Man's Space Lab'

THREE MICE were sent into space in a nose cone and recovered alive recently at a total cost of approximately \$20,000.

This neat low-budget accomplishment was made possible by the existence of "Space Lab," a little-known and unpublished service of General Electric's Missile and Space Vehicle Department.

Officials at MSVD like to call it the "poor man's tool" for space research.

Several years ago, these officials realized that they had a lot of space on their Mark 2 re-entry body. They approached the Air Force's Cambridge Research Center with the idea that this space should be utilized by scientists who had experiments that required a space environment, but didn't have the funds to pay for booster and range facilities.

Once the Air Force had given its blessings, MSVD established the Space Lab Program—then known as the "J" program.

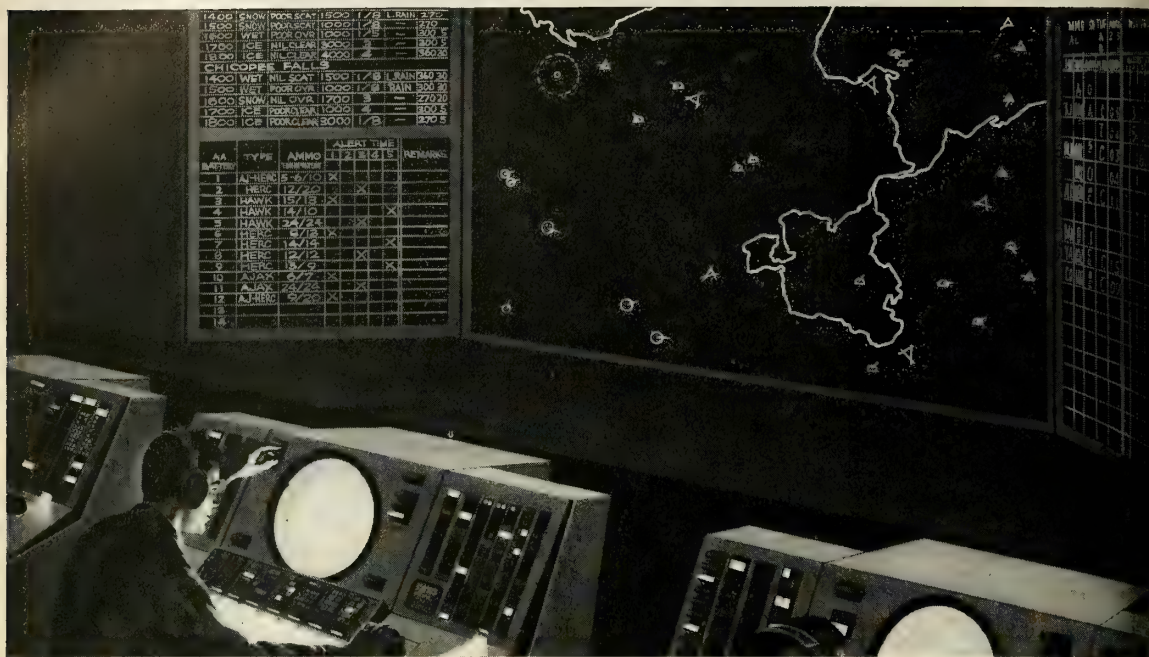
The limited space available on the Mark 2 meant that only two and one-half experiments could be flown per vehicle. However, when MSVD began producing the RVX 1 and 2 re-entry vehicles, the number of experiments that could be carried on a given flight took an order-of-magnitude jump to 16-18. With the advent of the Mark 6 program, it will be feasible to increase the number of experiments to 50.

• **How it functions**—Long before an anticipated flight, MSVD sends out information to various scientific and industrial organizations—mostly within the Air Force, although the program is not limited to AF contractors—outlining the dimensions, volume, weight and other details of the re-entry body space available for experiments.

If a firm has an experiment that it wishes to fly, it submits a synopsis of the proposed test to MSVD. When all the requests are received, Space Lab officials compile a list of the experiments in order of priority. This is submitted to the Air Force for approval. Once the list is approved, the experimenter is notified.

• **Ground rules**—Anyone flying an experiment understands that, since the missile flights have other primary missions, their package goes along on strictly a non-interference basis. Once it is installed aboard the re-entry body, it will not be monitored during checkout and only the most rudimentary functions—such as turning on power prior to liftoff—will be accomplished. \*\*

In single point defense, vital detection and tracking information is supplied automatically to human decision-makers within seconds. Effective direction of both manned and unmanned weapons, including return of manned aircraft to base, is a system function.



# 412-L STAFF EXPANDING

## as program moves ahead in advanced development phase

Write in confidence to Mr. P. W. Christos, Div. 73-WP  
**DEFENSE SYSTEMS DEPARTMENT** (A Department of the Defense Electronics Division),  
 General Electric, Northern Lights Office Building—Syracuse, New York

**GENERAL  ELECTRIC**



# A look at what's ahead in the realities of space exploration

*Some predictions from Douglas  
—the company that has helped  
launch 70% of all U.S.  
satellites & space probes*

Our mastery of space has advanced so rapidly that only diehard pessimists doubt the moon and planets will know our footsteps within a few decades.

Already a vehicle capable of orbiting 19,000-pound payload, or driving 100,000 pounds to escape velocity, or lifting 2,500 pounds to Mars or Venus is being built in the U.S. This is Saturn, taller than a 14-story building, with an initial thrust of 1.5 million pounds. Its second stage, under construction for NASA by Douglas, will use a cluster of liquid hydrogen-oxygen engines of unique design.

The world knows a man can rocket into space and return. Can he survive for long periods? Douglas studies give a strong affirmative. Zero gravity and artificial G require further study. Radiation is a continuing problem, but reports from Discoverer XVII, one of 46 space projects launched by the Douglas Thor rocket, show the threat less serious than was first thought.

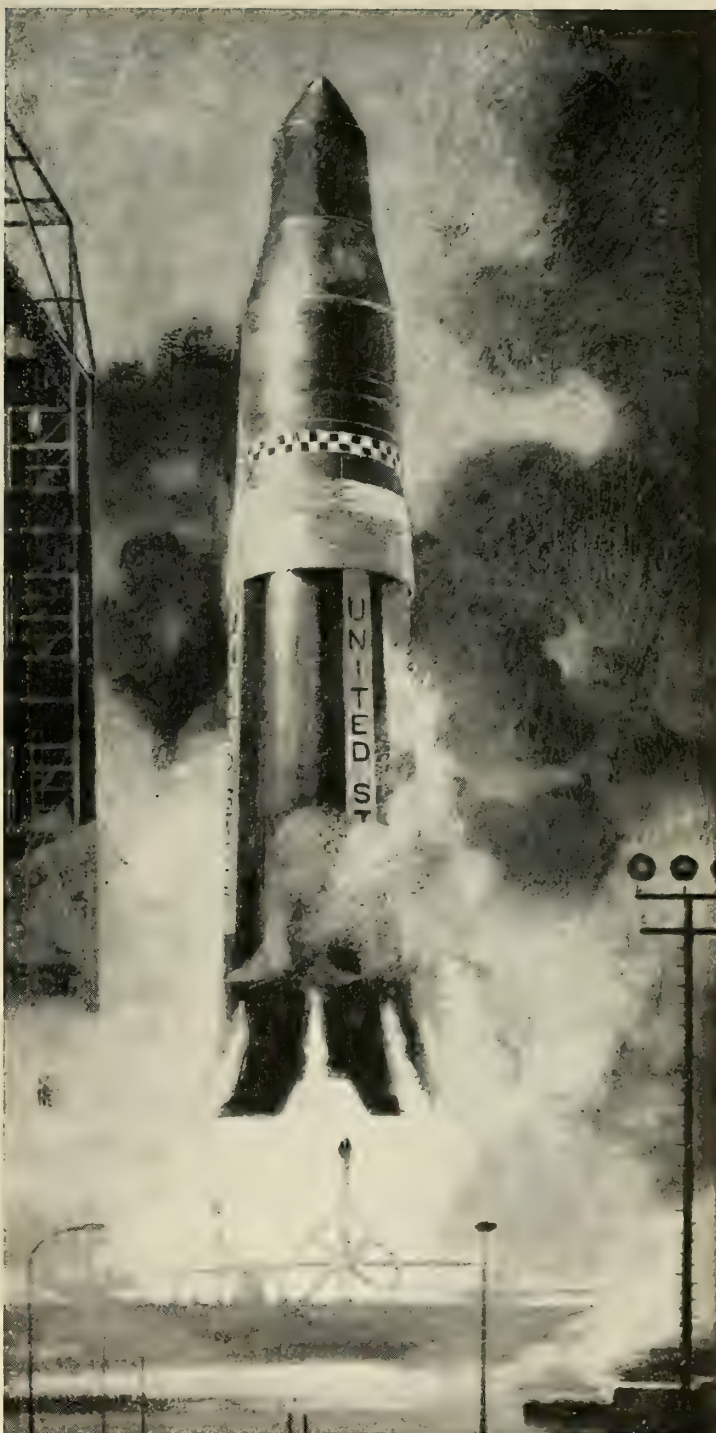
The cost of space travel? A breakthrough in nuclear power, which Douglas engineers confidently predict, should cut the operational cost of a trip to the moon to about \$900 per passenger. Other power sources, already under study, may even open such stars as Sirius and Alpha Centauri to travel.

## **The DC-8 Jetliner, an example of Douglas aero-space leadership**

Few of us will ever be lunar commuters, but growing millions are learning about a new kind of travel through the DC-8 jet.

Here is an airplane that slices through time at 10 miles a minute, opens the world to all who have the urge to get up and go places.

Next trip, fly a DC-8 jet, newest of which is the DC-8 Series 50, fastest long-range jetliner in the sky.



Douglas is building Saturn's 2nd stage.

# DOUGLAS

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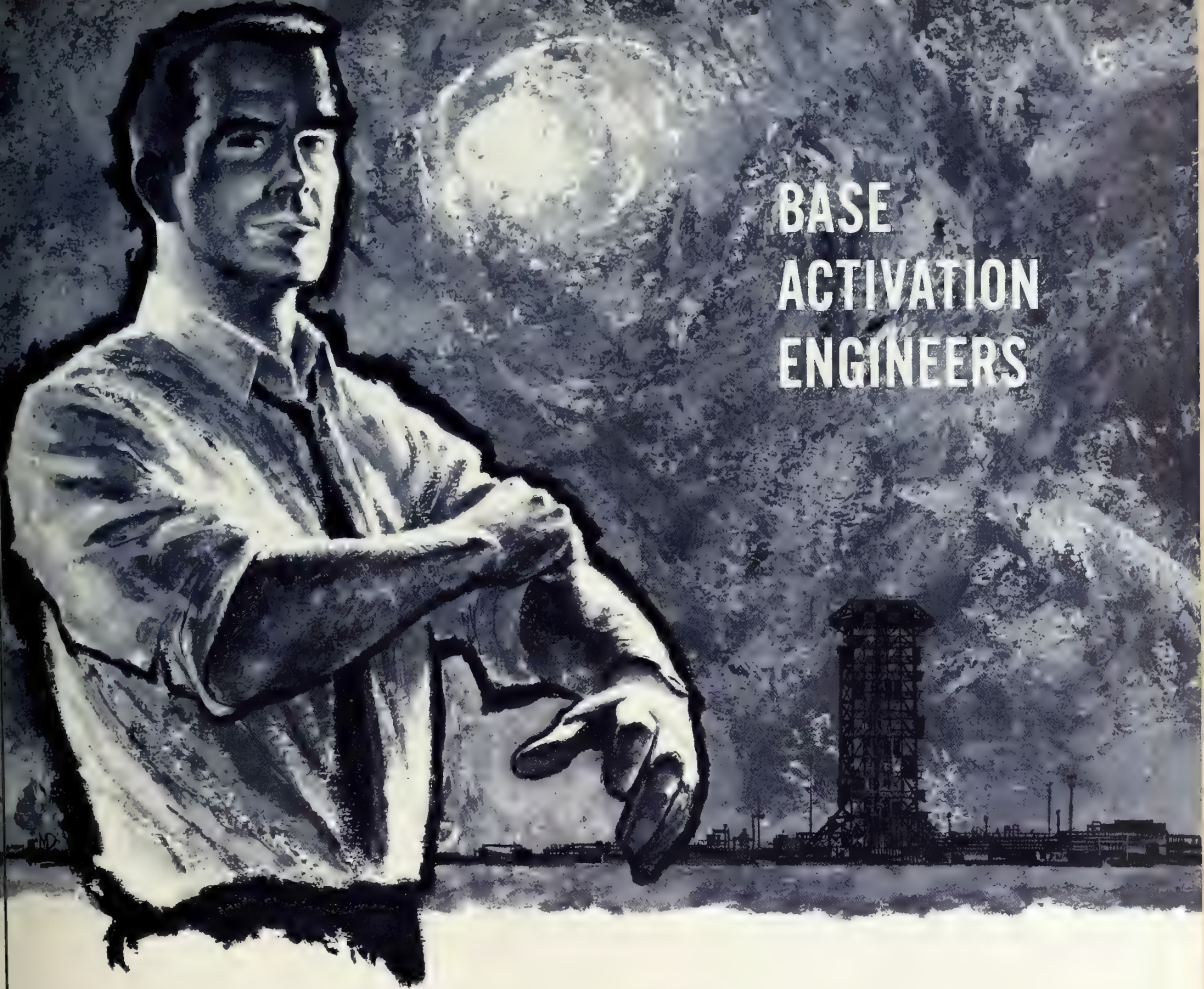
# 50 MILLIONTHS

The rotor of Sperry's new Mark 1 Mod. 2 gyro spins on a cushion of hydrogen, with clearances of only 50 millionths of an inch between it and the journal. The gas bearing, replacing the ball bearing of earlier models, reduces both production time and cost—and at the same time provides 300 to 400 percent higher accuracy for the Sperry Mark III SINS (Ship's Inertial Navigation System) designed for Navy's Polaris subs.

This big bonus in accuracy will be of vital importance to the Polaris missile; the entire system accuracy derives from it. And the accuracy must be there not for the few minutes it takes to put a missile on its trajectory, but for the days, weeks and months it is poised for action in the submarine beneath the sea. Actual Navy tests of production units of the Mark 1 Mod. 2 have shown it to surpass today's gyro standards many times over. With slight modifications to present inertial systems, these second generation gyros can replace their predecessors for added navigational accuracies.

**SPERRY**





## BASE ACTIVATION ENGINEERS

If you are a hardware-oriented engineer who enjoys the shirt-sleeve atmosphere of field assignments, General Dynamics | Astronautics offers you an important role in the activation of Atlas ICBM bases throughout the United States. The basic task is providing a wide range of technical assistance to the Air Force in bringing bases to operational capability.

Base Activation Engineers function at the systems level in the installation, checkout, and acceptance of ground support and missile-borne equipment. Specific requirements and locations of work are detailed on the back of this page.

These positions provide stability, growth opportunity, and the satisfaction of working on a program which is not only technically advanced, but of vital significance to the security of the free world.

*For a prompt, confidential reply, use the attached Professional Placement Inquiry card or write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Department 130-90, General Dynamics | Astronautics 5700 Kearny Villa Road, San Diego 12, California. Candidates who live in the New York area may find it more convenient to contact Mr. E. Hart or Mr. T. Cozine General Dynamics | Astronautics, 1 Rockefeller Plaza, New York, telephone, Circle 5-5034.*

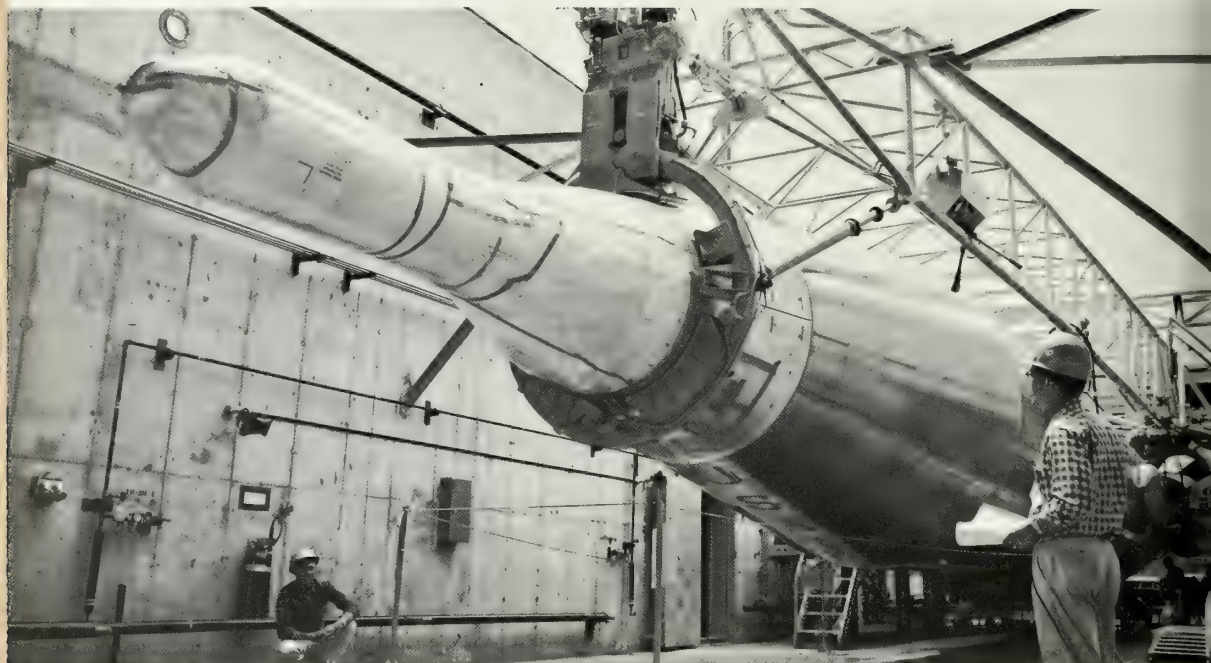
GENERAL DYNAMICS



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# ENGINEERS FOR BASE ACTIVATION



ATLAS MISSILE shown in horizontal launcher at operational base. Current assignments for base activation engineers are at Oklahoma; Abilene, Texas; Roswell, New Mexico; Plattsburgh, New York.

## DESIGN/LIAISON ENGINEERS

Tasks involve liaison and design support work in connection with launch control equipment, propulsion systems, automatic programming and missile checkout equipment. A degree in mechanical or electrical engineering and systems experience desired.

## ENGINEERING WRITERS

To prepare maintenance, operation, and inspection manuals, and engineering proposals. At least two years of college engineering and from one to three years of experience in this field desired.

## FIELD SERVICE ENGINEERS

Assignments are for specialists capable of representing the company to the Air Force in technical aspects of the Atlas ICBM. An engineering degree and field experience desired.

## ELECTRICAL/ELECTRONIC ENGINEERS

Graduate engineers with field experience in launch controls, logic control systems, automatic checkout equipment, guidance and flight control, facility electrical power, electronic systems, R.F. systems, telemetering landlines, or autopilots.

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# Shepard on Apollo:

## Manned Control Called Essential to Success

LOS ANGELES — Astronaut Alan B. Shepard, Jr., predicts that manually operated systems will be the rule in the Apollo program, including all stages of the booster.

"It is my feeling," Shepard told the Society of Experimental Test Pilots, that man can provide the input to actually fly the spacecraft into orbit, control the velocity vectors into a trans-lunar trajectory, perform midcourse corrections, execute the moon landing and take-off and provide the necessary control during re-entry and landing on the earth."

Man, he indicated, will be used in the Apollo program in the same way project Mercury utilized parallel systems to insure reliability.

"For example, many of the final stages or segments of thrust vectors would be satisfied prior to leaving the earth. The crew could get outside, go back to the appropriate stage once the flight was in space, and arm or prep or perhaps repair the particular power stage required. If one is to walk around the moon, collect samples, and prepare for take-off, why not do the same timely functions on the way out or the way home?" America's first astronaut said.

• **Leeway for landing**—In addition, Shepard said that man appears to have a definite place in the operation of the spacecraft.

Besides operating as a team during critical periods of flight such as takeoffs and landings, the crew will also function on a watch-sharing basis during long periods of translunar or transearth flight.

Final external configuration for Apollo has not been decided, Shepard said, adding that it is valid to assume that a lifting vehicle will allow for adjustment of trajectories on return at escape velocities.

Shepard said that in-flight repair or exchange of modular-type equipment may very well assure the success of the mission.

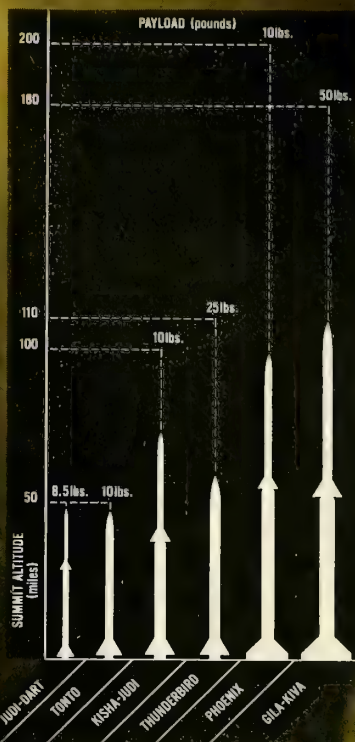
"Last, and perhaps most important," he declared, "it does not appear realistic to assume that a moon landing can be made using automatic systems and a command system functioning solely from an earth base."

"Exploratory probes can perhaps be made and lunar orbit data can be obtained using automatic unmanned systems. But landing and return, within the time period allotted, is not within the state of the art unless we provide the man for reliability," he concluded. ✱

...miles and rockets, October 16, 1961

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## Atlantic Research Doubles Work Space at Home Plant

ATLANTIC RESEARCH Corp. has dedicated a \$1.6-million building which doubles working space at its headquarters and principal laboratories in Fairfax County, Va.

The 123,000-sq.-ft. addition houses two ARC divisions—Jansky & Bailey and Desomatic Products—which were formerly located elsewhere in the Washington, D.C., area, as well as the company's Electromechanical Division.

Vice Adm. William F. Raborn, chief of the Navy's *Polaris* program, was main speaker at the dedication ceremonies. He singled out ARC's work in improving the specific impulse of solid propellants as the "key" to making *Polaris* feasible.

Rear Adm. D. M. Morrison, Chief of Operations, U.S. Coast Guard, delivered a special commendation to the Jansky & Bailey Div. for outstanding services in the field of maritime communications and navigation.

Atlantic Research has diversified its interests, acquiring seven firms in related areas since 1959, but its chief work continues to be in solid-propellant rocket research and manufacturing.

ARC has been researching for some time its gel-solid concept of propulsion for big space boosters. It has also been studying slurry fuels for several years, and recently received a \$250,000 Air Force contract to support this effort.

The company manufactures the *Arcas*, *Archer* and *Iris* research rockets, is in initial production of an advanced sustainer rocket for the Navy's *Terrier*, and is completing development of a combination booster-sustainer motor for the Army-Marine Corps *Redeye* shoulder-fired antiaircraft missile.

Founded in 1949, the firm's original staff was composed of Dr. Arch C. Scurlock and Dr. Arthur W. Sloan, the co-founders. Its initial capitalization was \$1000. Today it has more than 1800 employees and net worth of \$9,507,845.

President Scurlock announced at the dedication that new orders received during the first six months of this year totaled a record \$11.7 million.

As reported earlier (M/R, Sept. 4, p. 45), ARC sales during the first half were \$9,039,071—up 51% from the same period in 1960. Net earnings were \$606,036 or 34 cents a share, compared with \$329,482 or 21 cents a share in the first half last year. ■

**THE MARTIN CO.** and American-Marietta will consolidate into the Martin-Marietta Corp. George M. Bunker,



## Big 'Dish' Erected at Stanford

*THE STANFORD DISH*, a \$350,000 research instrument designed and built by Stanford Research Institute scientists supported by the Air Force Office of Aerospace Research, is a 70-ton, 150-ft. steel and aluminum parabolic antenna.

Martin chairman, will be president and chief executive officer and Grover M. Hermann, A-M chairman and founder, will be chairman of the new board of directors.

**PRATT AND WHITNEY AIRCRAFT**, division of United Aircraft Corp. has established an Advanced Materials Research and Development Laboratory to produce new materials for aircraft, space and industrial powerplants of the future.

Principal goals of the Lab will be development of high-strength materials, alloys for service at extreme temperatures and materials for energy conversion devices.

**ELGIN NATIONAL WATCH CO.** will double its Micronics plant production space. Elgin's president, R. O. Fickes, said the additional space is necessary for production of missile and space equipment. "We expect to participate to a much greater degree," Fickes asserted, "in advanced systems and programs as they are called for by the defense program and private industry."

**GARRETT CORP'S** AiResearch Manufacturing Div. of Los Angeles is expanding its product line into storage, transportation and pumping of cryogenic fluids for ground support.

The expansion will include new products, a new facility and addition of engineering and fabrication personnel.

No details on a site for the new facility were announced.

**NATIONAL CARBON CO.**, Division of Union Carbide Corp., says it is planning a \$500,000 expansion of its Lawrenceburg, Tenn., facilities for the production of high-density graphite for the nation's space program.

**THE BOEING CO.** has consolidated its advanced marine work into one group, the Advanced Marine Systems Organization.

Work includes a \$2-million hydrofoil subchaser under construction for the Navy. The test program will include use of the division's hydroplane, recently completed to test foils and other marine shapes.

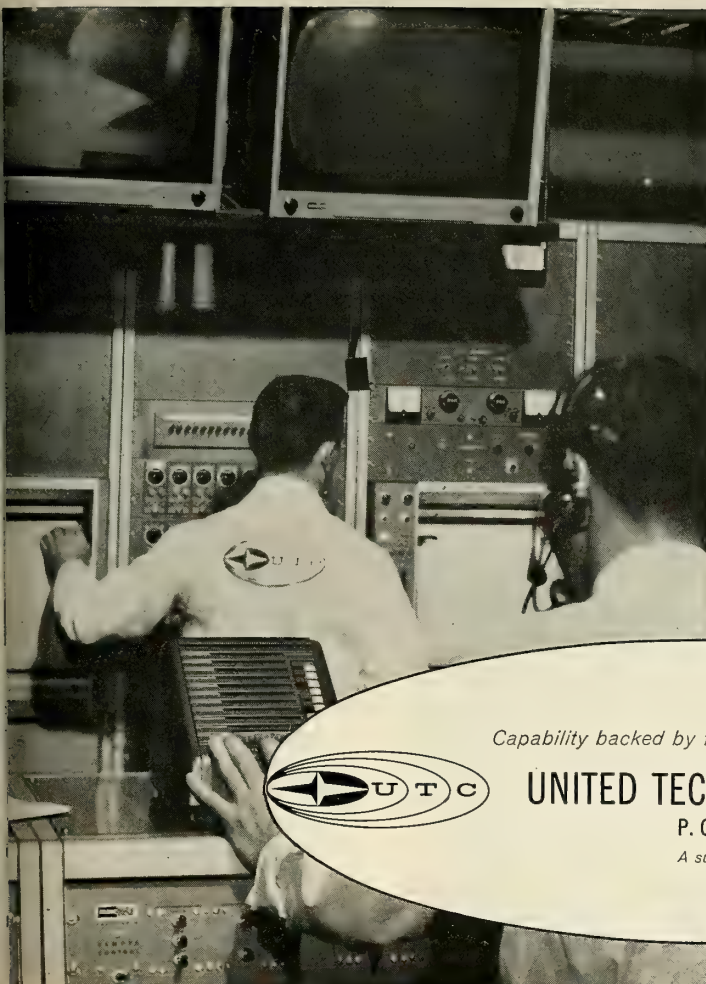
The new organization will also be responsible for a broad effort in ASW and other marine programs now underway.

**PROPELLANT TECHNOLOGY**, Palmdale, Calif., has been formed to process composite solid propellants and produce solid-propellant manufacturing and testing equipment.

Operations have been scaled to provide services to the small batch user of custom solid propellants. Testing facilities will accommodate rocket motors up to 15,000 lbs. thrust.

Reaction Devices, the equipment manufacturing division, produces full automatic laboratory solid-propellant





Left—The scene: UTC Development Center. The action: static firing test is monitored on closed-circuit TV in Remote Control and Data Acquisition Center.

## INTERVIEWS NOW ARE BEING CONDUCTED FOR THESE POSITIONS

**Sr. Design Engineer**—Supervision of a group in design of solid rocket motor components. Requires professional degree and a minimum of 5 years rocket design experience.

**Engineering Analyst**—Systems Design. To formulate mathematical models of systems engineering problems and implement solutions by analytical techniques. Requires degree with solid mathematical foundation and 2 years design or systems experience.

**Organic Chemist**—Propellant development research involving synthesis of basic monomers, plasticizers and organic compounds. Requires an advanced degree in organic chemistry with a knowledge of advanced organic synthesis. Experience in synthesis of reactive compounds is most desirable.

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**Research Processing Chemist**—For laboratory investigations of polymeric materials that may be used as liners, and adhesive or encapsulating agents, and allied research. Strong background in organic chemistry and synthesis including a degree in chemistry or chemical engineering is necessary.

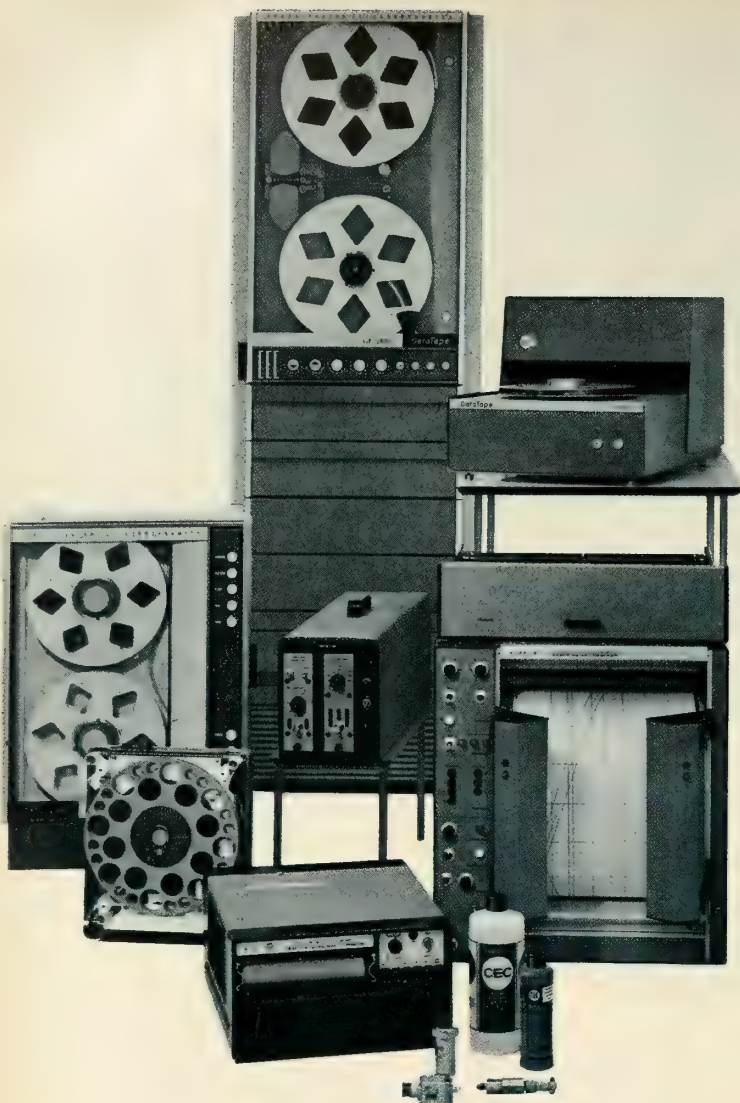
**Aerothermo Specialist**—Will perform heat transfer thermodynamic and aerodynamic studies on rocket motors, develop new methods of analysis and design tests. Will consult with designers and project engineers on major engine programs. Requires masters degree in mechanical or aeronautical engineering and 4 years experience in thermodynamics and heat transfer.

**Process Engineer**—For rocket motor processing studies and process methods improvements. Requires chemical engineering degree and direct propellant processing experience.

**Propulsion Engineer**—For analytical studies of solid and liquid propulsion systems. Requires degree with extensive mathematics, thermodynamics and fluid mechanics background.

**Positions also for process operations supervisors.**

All qualified applicants considered without regard to race, creed, color or national origin.



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mixers, controlled flow-rate strand burning apparatus, propellant shock testing equipment, small rocket motors, sounding rockets and custom engineered propellant apparatus.

**KEARFOTT DIV.,** General Precision, Inc., has begun work on an addition to its Gyrodynamics building in West Paterson, N.J., as part of a 100,000-sq.-ft. expansion program.

A new research center will assist Kearfott's product-line divisions in development of advanced equipment for control of missiles and spacecraft.

**MONSANTO RESEARCH CORP.** will begin production and marketing of radioactive sources at its Dayton Lab this fall.

Construction of a radioactive facility and installation of equipment for the production of the nuclear sources is now in progress, and application has been made to the AEC for necessary operating licenses.

**WESTINGHOUSE ELECTRIC CORP.** has formed a new space materials department to coordinate company activities in development and application of structural materials that will withstand environmental conditions of space, re-entry and hypersonic flight.

The department will be located in the Westinghouse research labs at Pittsburgh, and will focus attention on materials for such structural components as rocket nozzles, vector control mechanisms and nose cones.

**ELECTRONIC MEMORIES, INC.,** Los Angeles, has been formed to develop, design and manufacture ferrite memory cores and core memory systems. Cores for space and adverse environment applications are being developed as well as memories having low power requirements and high reliability for space systems.

**GENERAL DYNAMICS/ASTRONAUTICS** has put into operation an underwater explosive part-forming facility designed to form special parts for spacecraft.

Explosions take place in a 12-ft. tank, part of the new \$40,000 facility comprising two buildings, a five-ton hoist and two explosive magazines.

**SPARTAN SOUTHWEST, INC.,** a subsidiary of Spartan Corp., has dedicated its military electronic facility at Albuquerque, N.M. The 32,000-sq.-ft. building contains general offices; engineering, drafting and laboratory facilities; white room; environmental test lab and plating room.

**RAYTHEON CO.'s** Semiconductor Division will establish headquarters in Lowell, Mass. The move will consolidate five separate activities in the Boston area. The company estimates that some production will be under way by early November.

missiles and rockets, October 16, 1961



**WESTINGHOUSE** has more than doubled its Sunnyvale, Calif., *Polaris* launcher manufacturing facilities.

The expansion, completed in 15 weeks, brings to 1,304,000 sq. ft. the total working floorspace at Sunnyvale, and augments *Polaris* launcher research, development and manufacturing.

Concurrent with obtaining added space, Westinghouse ordered 25 new lat machine tools to turn out *Polaris* parts. Ten machines have been installed and 15 more—five of them automatic die-control types—will be added by the end of this year.

#### **SPECTRAN ELECTRONICS**

**SRP** has been formed in Maynard, Mass., to develop and manufacture magnetostriction components and instruments. Products will include multi-filter spectrum analyzers for sonic and electromagnetic waveform studies, magnetostriction rod filters for frequency reference, analysis and signal selection. The firm will also offer research and product-development services.

**VITRO ENGINEERING CO.** will build the first nuclear rocket engine maintenance and disassembly building in the nation. The facility will be the major component of the National Nuclear Rocket Development Center, which is expected to be built at the AEC's Yucca Flats, Nev., test site. Engineering work is being financed by NASA.

### **1st Saturn Launch**

(Continued from page 17)

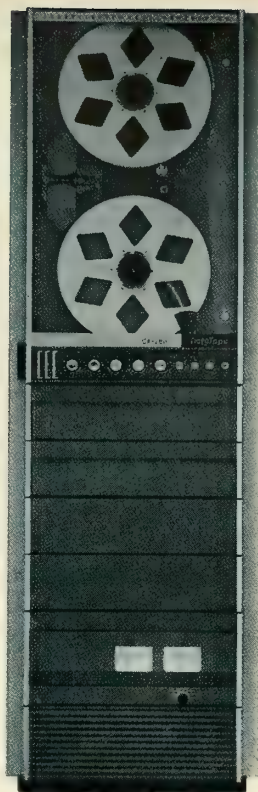
This week's shot will be the first of developmental shots which are expected to lead to an operational *C-1* booster in 1964. The *Saturn*'s prime mission is to put a three man *Apollo* spacecraft into orbit around the earth. NASA officials said that while they are optimistic about the chances for success in this week's flight, it is reasonable to expect only about five successful launches out of the 10 scheduled.

The first *Saturn SA-1* vehicle is 162 ft high. At liftoff it will weigh about 2,000 lbs. For early flights, the eight engines in the first stage are rated at 55,000 lbs. of thrust each, giving a stage thrust of 1.3 million lbs. Beginning with flight number 5, the engines will have a thrust of 188,000 lbs. each and a stage thrust of 1.5 million lbs.

In the first flight, the booster will carry some 600,000 lbs. of propellant, about 150,000 lbs. less than the rated capacity.

The inert *S-IV* second stage, weighing about 25,000 lbs. will be ballasted with 90,000 lbs. of water. The inert *S-V* third stage has a stage weight of nearly 30,000 lbs. and will be ballasted with 100,000 lbs. of water. ❖

ships and rockets, October 16, 1961



## meet the latest member

For a new product, CEC's GR-2800 Recorder/Reproducer is grown-up indeed. It is more versatile, has a higher stability and costs less than any comparable instrument. Proof is in its features: solid state electronics; direct, FM and PDM modes; plug-in amplifiers interchangeable with PR-3300 electronics; magnetic amplifier tape tension control; six standard speeds 1 1/2 to 60 ips; direct record response 100 cps — 100 kc; FM response 0 - 10 kc; and 14-channel recorder/reproducer in a single cabinet. □ Want to know more? Call your CEC office or write for Bulletin CEC 2800-X6.

# CEC

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# Asides at the ARS Meeting

- First experimental Bell System active communications satellite is scheduled for launch by NASA next April. The second is to be launched six months later. Bell displayed a full-scale model of the satellite as a Coliseum exhibit. The company now is testing a developmental model of the satellite in an anechoic chamber at its Holmdel, N.J., laboratories. Bell plans to produce six of the 34-in.-diameter, 150-lb. spheres—one for each launch plus its backup and one spare. Powered by 72 solar-cell arrays, the satellites will be used for experiments in relaying telephone calls, TV signals and for data transmission.

- Increased production—dubbed the "Berlin add-on"—at the Naval propellant plant in Indian Head, Md., is one result of the Berlin crisis. New schedules call for telescoping two years' production into one year, with corresponding increases in the manufacture of five missiles—*Sparrow*, *Sidewinder*, *Zuni*, *Terrier* and *Tartar*. The plant also is being held in readiness for a further production buildup.

- The White House, Atomic Energy Commission and the Department of Defense are taking another look at *Vela Hotel*, the detection system for nuclear explosions in space. No flaws have been found in

the planned *Vela Hotel* satellite system but the Administration wants to make sure the system still is the best means of doing the job. As a consequence, no contract has been awarded for the structure, control system or telemetry equipment for *Vela Hotel*, despite design freeze of the detecting and logic portions of the payload at Los Alamos Scientific Laboratory and the Sandia Corp. Contract award now may be delayed until the dust settles in the present international situation.

- Friction between exhibitors and local unions marred early preparations for the big ARS display. Almost every exhibitor had troubles and some were annoyed to the point of seriously considering a boycott on any future dealings with the Coliseum. Industry participants had high praise, however, for the way the entire meeting was handled by ARS.

- Yugoslavia will initiate a sounding rocket program early this spring with the launch of the first of five *Kappa-VI* rockets bought from Japan. Vladislav Matovic, secretary of the Yugoslavia Astronautic Society, told M/R that his society subsequently will build *Kappa-VI's* under license and eventually will be designing and building sounding rockets of its own to explore the upper atmosphere.

## Biggest ARS Meeting

(Continued from page 1)

Tests have shown, according to A. Lingham, that the apparent thermal conductance of this system at chamber altitudes of 200,000 feet is approximately 10% less than with non-ventilated insulation.

- **Vehicle recovery criteria**—As much as 20% of program costs could be saved if space vehicle boosters could be recovered, two Marshall Space Flight Center engineers pointed out.

Reporting on a study being conducted at Marshall, William Porter and R. G. Voss said that recovery is clearly attractive if the combined cost of the recovery operation and refurbishment is less than 55% of the cost of a new booster.

On the basis of immersion tests conducted on a H-1 engine, they discounted the effects of salt water on rocket engines. They proposed that a program using parachute recovery of boosters be initiated.

This recommendation is based not only on the salt-water tests but also on the inability of the Rogallo wing to return to Cape Canaveral without supplemental power or a tow aircraft.

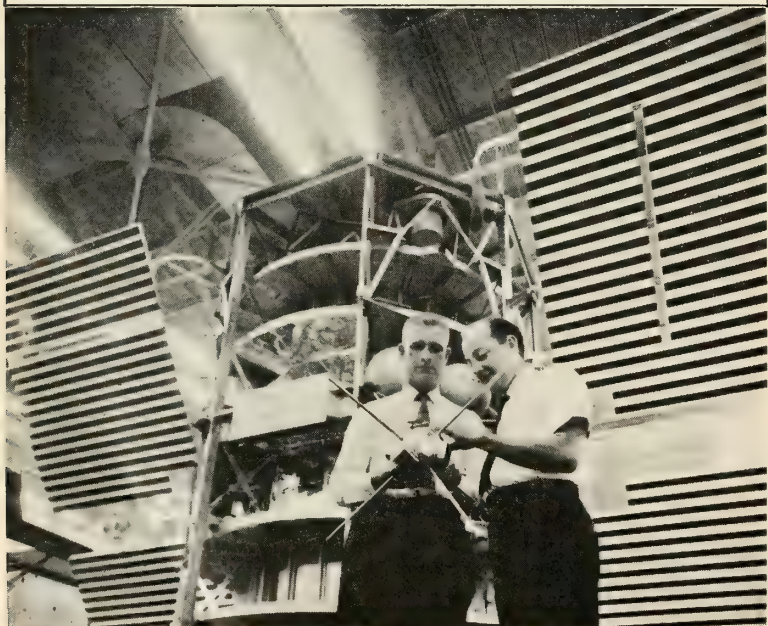
- **Transportation of boosters**—After investigating air, water and overland transport of very large boosters, Marshall Co. engineers have concluded that a transport would be the most economic means of booster transport.

The primary advantages cited by Beal M. Teague and John R. Yourquist are flexible scheduling, free from delays such as occurred with *Saturn* at Wheeler Lock, and rapid transport of the booster.

For boosters up to 30 ft. in diameter with gross weights of 100,000 lbs., a glider towed by a C-133B aircraft would be practical. However, for larger boosters, a new tow aircraft at a development cost of \$13 million—would be required.

- **Cryotron production shown**—The production techniques and equipment used to manufacture the cryotron—thin-film, micro-miniature memory units—were displayed by IBM for the first time.

The device is manufactured in a bell-shaped vessel by deposition of cryotron material on a plate. The temperature within the bell is maintained at -459°F during the six-hour production time. The cryotron is expected to enable computer engineers to increase the memory capacity and speed of computation and at the same time radically reduce their size.



CONTRAST at ARS meeting was supplied by full-scale model of Orbiting Astronomical Observatory and Vanguard I, here held by project engineers of Grumman, OAO prime.



# New 3-D Systems May Revamp Tracking

by Charles D. LaFond

CHICAGO—Two radically new three-dimensional display systems are being developed to present a target trace with 3-D continuous images in real time. Under study for the past 2½ years at the Applied Research Laboratories of Chrysler Missile Division in Detroit, the systems may have far-reaching effects on future displays for space exploration and rendezvous, ASW, missile trajectory determination, and other tracking applications.

The first employs a transparent tank of colorless gel in which an ink trace is deposited by a moving stylus. Semitransparent, the gel offers essentially no impediment to the stylus, yet it is firm enough to suspend the trace. Theoretically, the display tank can be of almost any size, developers say.

The second approach is electronic, using the concept of light impingement on a rotating screen. Screen speed about the vertical axis is high enough—15 rps—to render it invisible to the human observer. The total area swept by the screen describes the 3-D display volume. By projecting different light beams into the display volume, lines and surfaces are generated. With proper synchronization—and by employing a combination of axial beam entry, curved and sloping screens, simultaneous forward and reverse readout from a memory unit, and other techniques—almost all of the display volume can be used.

The electronic approach is much faster than that achieved with the gel, and both represent truly 3-D display techniques and thus could be an ideal complement to radar tracking or control stations. Real-time presentation would be accomplished using inputs from a computer.

Details of Chrysler's research effort were presented last week at the 17th Annual National Electronics Conference and Exhibition in a paper by C. K. Aul and C. W. Gattas.

• **NEC details**—Meeting for the first time in Chicago's International Amphitheatre, well over the expected 1200 electronics scientists, engineers and university students assembled from across the nation to exchange their knowledge. More than 80 technical papers were presented at 20 sessions during the three-day conference.

Although the technical sessions ranged from antennas and bionics to solid-state physics and space communications, the exhibits were notable for lack of interesting systems. The small component was dominant here, and after viewing over 450 stalls showing everything conceivable in electronic hardware, many attendees sorely felt the absence of military and space displays which tend to break the monotony.

The three principal speakers at the conference luncheons were Dr. Lloyd V. Berkner, Institute of Radio Engineers president; Army Brig. Gen. David P. Gibbs, North American Air Defense Command deputy chief; and Robert W. Galvin, president of Motorola, Inc.

Gen. Gibbs, who directs NORAD's communications and electronics systems, reviewed the capabilities of that command and stressed the almost complete dependence of NORAD on C&E operations.

Indicative of the constant modernization of the vast AF electronics complex, he said, is the recently established SPADATS—Space Data and Tracking System—which acquired and tracked Soviet Maj. Gherman Titov's capsule during its orbital passes last summer.

The soon-to-be-operational *Midas* infrared detection satellite system is a similar advance, he asserted. Not only will it complement BMEWS, the Ballistic Missile Early Warning System, but it will provide much-needed early warning coverage of U.S. southern approaches.

Finally, Gen. Gibbs stressed the current need for an effective and reliable anti-ICBM. *Nike-Zeus* may eventually do the job, but it still needs "orders of magnitude increase in improvement," especially in its abilities for target acquisition and discrimination. An ICBM priority is needed, he urged, but not to the detriment of our proven air-breathing weapon systems.

• **3-D display concepts**—True three-dimensional displays are needed, said Aul and Gattas in their paper, to help solve an inherent weakness in operators—the incompatibility in the human mind of high precision and high speed. The use of realistic 3-axis display would improve operator efficiency by offering him the opportunity to evaluate more

rapidly a potentially imminent undesirable or dangerous situation.

To react with alacrity, the engineers asserted, displays are needed that will permit man to sense rather than analyze both the nature and magnitude of a problem.

• **Gel-type system slow**—Speed of the gel-type system—1 inch per second—is considerably slower than that of its electronic counterpart. The display, however, is updated continuously and also shows the desired portion of past history. For missile trajectory, an entire flight path could be shown as it progressed.

The gel display was developed first.

Grids, charts, maps, or even solid models can be placed in and around the transparent tank for reference purposes. Light plastic models can be suspended indefinitely in the gel without support.

For a more vivid display, fluorescent inks in a variety of colors may be used.

Accuracy of a displayed trace, developers said, is limited only by stylus deflection, and slightly by the passing of a stylus through a previous trace. Lab models currently are operating at 1 ips and provide accuracies on the order of 3% of error.

Gel life so far appears indefinite.

The stylus is driven in each axis by a positional servo-loop. The present system is designed to follow Cartesian coordinates with input voltages of from 0 to  $\pm 100$  volts. It can be offset by 100% and may be driven directly from an analog computer.

Input to the display is provided by three chart-scanning function generators. These are synchronized to seam simultaneously all three channels for the 3-D display.

• **Rotating screen system**—Synchronization of the rotating screen and controlled generation of a light spot or line projected into the area swept by the screen will provide a dynamic 3-D display, according to the authors.

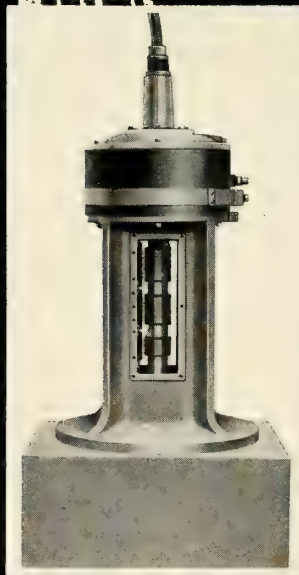
A spot projection generates a pencil beam, a line generates a ribbon beam in space. Interception of either light beam in the screen plane of rotation generates either a line or sheet of light in three dimensions. As the light source moves, so does the area of screen impingement. ■

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## —names in the news—



PICCARD



PERENIC

**Dr. Claus Haake:** Appointed research manager, Giannini Controls Corp.'s Research Laboratories, Pasadena, Calif. Prior to joining GCC, Dr. Haake served as senior physicist for Westinghouse Electric Corp.

**Robert W. Mytton and Charles G. Stemmmons:** Appointed operations manager and sales manager, respectively, Kollstar Semiconductor Elements, a division of Kollman Instrument Corp., Westbury, N.Y.

**Dimitri Rebikoff and Jacques Piccard:** Appointed director of operations and consultant, respectively, for Loral Electronic Corp.'s new oceanography activities. Rebikoff is an internationally known underwater expert, photographer and inventor. Piccard is a consultant on oceanography for the U.S. Navy and recently co-authored a book entitled "Seven Miles Down—The Story of the Bathyscaphe Trieste." He also is the son of **Auguste Piccard**, inventor of the "bathyscaphe."

**Lawrence J. Perenic:** Joins S-F Laboratories, Union, N.J., subsidiary of Varian Associates, as senior project engineer, subsystems. Prior to joining S-F, Perenic was with ACF Electronics Division, ACF Industries, Inc.

**Dr. Charles M. Herzfeld:** Appointed assistant director for ballistic missile defense research in Defense Department Advanced Research Projects Agency (ARPA). Recently named associate director of National Bureau of Standards, Herzfeld has been given a year's leave of absence by the Bureau to serve with ARPA, where he will be responsible for coordination of the *Defender* program. **Albert M. Rubenstein** leaves his present position as assistant director for ballistic missile defense to become assistant director for ballistic missile defense engineering.

**Anthony M. Barbella:** Staff engineer, Instruments for Industry, Inc., Hicksville, N.Y., promoted to chief systems engineer.

**Frank J. Shanaberg:** Former manager of sales, Industrial Products Div., appointed vice president-marketing, The American Welding and Manufacturing Co., Warren, Ohio. **John P. Lynn:** Appointed general manager of the company's Industrial Products Div. Lynn formerly was manager of manufacturing.





BARBELLA



SEE

**Kenneth D. Greenhalgh:** Named manager, Undersea Acoustics Systems Engineering; **L. H. Lynn,** manager-Ordnance and Radar Systems Engineering; and **Earl A. Robbins,** manager-Marine and Ground Radar Systems Engineering; all in General Electric Co.'s Heavy Military Electronics Dept., Syracuse, N.Y.

**M. G. O'Neil:** President, General Tire and Rubber Co., elected to board of directors, Space-General Corp., Glendale, Calif., a subsidiary of Aerojet-General Corp.

**Dr. Elizabeth B. See:** Formerly with the El Segundo Div., Douglas Aircraft Co., as Acoustica Associates, Inc., Los Angeles, as a senior scientist in the Research Dept.

**E. V. Huggins:** Chairman of Executive Committee and vice president, Westinghouse Electric Corp., elected to second term as president of National Security Industrial Association, Washington, D.C.

**Wald J. Lynch,** vice president of Ford Motor Co.'s Defense Products Group, and general manager of Ford Aeronutronic Div., elected chairman of the board; and **Polycy E. Tuttle,** scientific advisor to Management, A & O Div., Eastman Kodak Co. named vice chairman of the board.

**Thomas Meloy,** chairman of the board, Lear, Inc., named first vice president; **Wesley A. Neumann, Jr.,** president, The Seal Separator Co., re-elected chairman of the Executive Committee; and **Raymond Smith,** vice president in charge of Defense Activities Div., Western Electric Co., became vice chairman of the Executive Committee.

**Larry J. Bolwell:** Elected vice president, Midland-Ross Corp., and general manager of the company's Surface Combustion Div., Cleveland, Ohio. Bolwell succeeds **Eugene Heiles,** who will retire early next year. In the interim, Heiles will continue as a vice president of Midland-Ross and serve in an advisory capacity to the Surface Combustion and other divisions.

**Col. William A. Bennett, Jr. (USAF):** Named administrator, Program Coordination, at Radio Corporation of America's Data Systems Division, Van Nuys, Calif. Bennett's last post of duty was at Wurtsmith Field, Mass., where he was staff officer in the Electronic Systems Center.



NOW...FROM WINSLOW

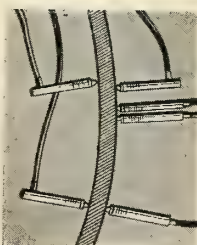
## New electronic gaging systems

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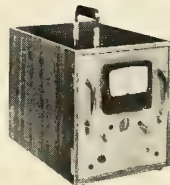


Uses Winslow Electronic Gaging Probes—sensitive transducers that substitute for standard dial indicators and most air probes in any mechanical "design" gage. Small size of the Probes ( $3/8"$  dia. x  $2-13/32"$ ) allows locating check points where never possible before. Probes can be completely hidden. Console CS-24 (above) shows gage position and variation in lighted numerals  $1"$  high, also prints this information on tape, card or sticker if desired. Push proper button to check any individual point, or machine automatically reads up to 24 gage positions and prints the results. Also reads "thickness" variation between any two opposed Probes. Accuracy possible to nearest .0001". Versatile—use with any number of "design" gages. Write for literature.

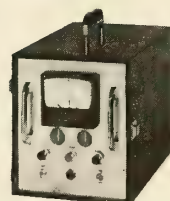
### ALTERNATE READOUT DEVICES



Model IN-27 reads out a single Probe on meter scale. Can operate automatic sorting devices, etc. Can be ganged to read multiple points simultaneously.



Model LP-9 Electro-Chek® reads each of 9 Probes on the meter as you touch the button. Lighted digital lamp identifies gage position. Optional limit pointers.



Model LP-18 Electro-Chek® reads up to 18 contour points. Also reads "thickness" variation between any two opposed Probes. Compact. Versatile.

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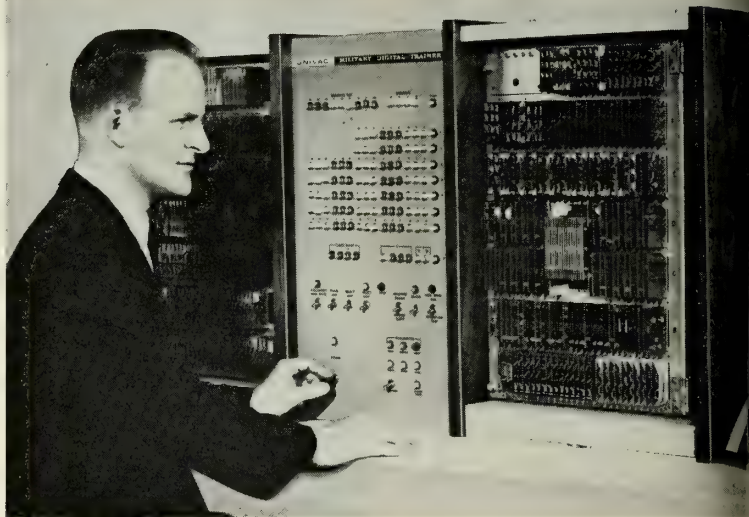


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## products and processes



### New Product of the Week:

#### Univac's Military Digital Trainer

THE UNIVAC Military Digital Trainer, a desk-size binary computer with many large-scale computer characteristics, is available from the Univac Military Department for applications ranging from training in computer maintenance, design and programing to the solution of many data-processing problems.

The portable unit occupies eight cubic feet of space and operates from 60-cycle, 110v ac power, dissipating a maximum of only 750 watts of electrical power.

Total computer characteristics of the Univac Military Digital Trainer include:

- A high-speed magnetic core memory with 512 fifteen-bit words of random access storage with a read-restore cycle period of 8 microseconds, and time of 24 microseconds, and multiply-divide time of 130 microseconds.

- Single-address instruction repertoire with j-bit options and B box indexing, plus regular divide and multiply instructions.

- A complete console, with all arithmetic and control registers available on the panel for operator intervention and for teaching operator procedure. All logical circuitry and test points are accessible to the operator.

Circle No. 225 on Subscriber Service Card

### Dual-gun Storage Tube

A dual-gun, 10-in. storage tube (Storatron) specifically adaptable to missile and satellite tracing is announced by the Electronic Tube Div., Allen B. Dumont Laboratories.

Designated type K-2087, the tube features excellent tracking accuracy between guns and raster orthogonality without resort to on-axis writing. It utilizes a patented gun structure to achieve deflection linearity within 0.1% (no deflection plate current).

Advantages of its dual guns are the ability to track from two separate an-

tennas or two angles or points. Storage time of the tube is from 3 to 10 minutes. The tube is adaptable to TV frequencies and can freeze TV presentations with excellent light output. An action can be frozen and observed while the action is still taking place.

Circle No. 226 on Subscriber Service Card

### Dacron-Epoxy Tubing

A heat-shrinkable dacron-epoxy tubing is being marketed by Westinghouse for slip ring applications. The tubing is intended to provide simple and precise slip ring positioning and to eliminate



use-tolerance machining operations at are generally necessary for the press-fitted slip rings. It is also intended to eliminate the alternative practice of using slip rings by splitting and then joining the segments to provide increased strength for slip ring structure. Tensile strength is 8500 psi, compressive strength is 17,200 psi, water absorption is 0.18%, and dielectric strength is 407 per mil.

Circle No. 227 on Subscriber Service Card

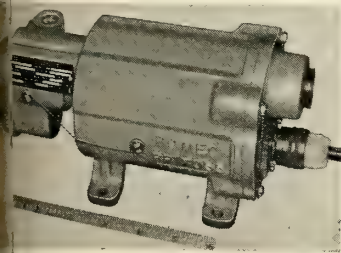
## Porcupine Delay Line

Valor Instruments, Inc. has available a miniature, multi-output porcupine delay line with 80 equally spaced taps arranged for easy identification and every wide variety of delay periods. Model DL 356 has a total delay of 4.0  $\mu$ sec and a tapped output every 0.05  $\mu$ sec. The hermetically sealed, multiple-output, lumped-constant delay line provides flexibility in delay selection for applications such as the proper phasing of multiple-channel tape recorders. Specifications as follows: delay-4.0  $\mu$ sec, time-0.15  $\mu$ sec, 80 taps in 0.05  $\mu$ sec intervals, impedance-100 ohms, attenuation-4 db max.

Circle No. 228 on Subscriber Service Card

## Coolant Pump

Lear-Romec is manufacturing an electric motor-driven coolant pump for operation in ethylene glycol/water mixtures and other coolant fluids. The motor stator of the RG17050 vane type pump assembly is encapsulated to permit flooded operation in fluids. This design eliminates shaft seals between pump and motor. The pump has a flow range up to 5 gpm and a discharge



pressure setting up to 200 psi. The minimum operating life is 5000 hours. The pump has a displacement of 0.324 cu. in. revolution and has a non-adjustable relief valve set to bypass full pump flow at 50 psig discharge pressure.

Circle No. 229 on Subscriber Service Card

## Fotoceram Grid Boards

Additional configurations in Fotoceram printed circuit grid boards have been developed by Corning Electronic Components. The grid boards consist

of copper-clad Fotoceram glass-ceramic with a grid of 0.052-in. through-plated holes set 0.1-in. on center. The circuit pattern is laid on the grid with etching resist, then the copper lying beyond the pattern is etched away. After this 15-min. process, the board is ready for components.

Circle No. 230 on Subscriber Service Card

## Predetection Receiver

Dymatronics predetection receiver provides, within a single assembly, a means for collecting telemetry data for recording prior to demodulation. I-f output for recording may be selected at 900, 450 or 225 kc. Playback from a magnetic tape recorder may be fed through the receiver and demodulated. Selection of 7 i-f bandwidths is obtained by means of plug-in bandpass filters. Afc is provided, activated by a panel switch, to reduce frequency drifts in the higher telemetry bands.

Circle No. 231 on Subscriber Service Card

## new literature

**PCM TELEMETRY** — A proven "off-the-shelf" PCM telemetry system is described in an illustrated brochure available from Radiation Inc. The brochure describes PCM evolution and the many applications of Radiation's PCM technology, citing systems employed by GE, Thikol and Norair. It also presents a review of the PCM systems designed and built for the Holloman sled program, Titan inertial guidance R&D, and Minuteman ICBM.

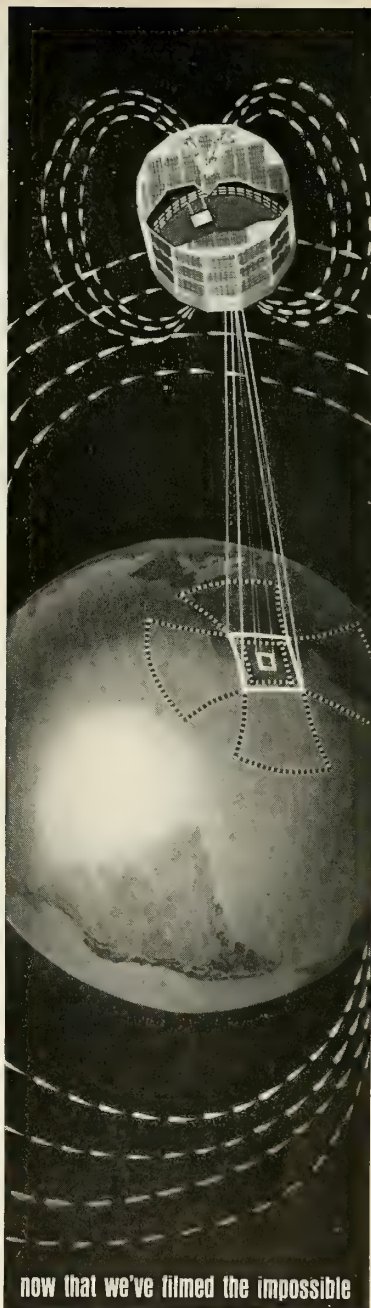
Circle No. 200 on Subscriber Service Card

**DATA ACQUISITION** — A brochure describing the MicroSADIC digital data acquisition system is available from Consolidated Systems Corp. It provides a technical introduction to MicroSADIC—an integrated, high-speed, general-purpose solid-state system capable of sampling several hundred channels of analog data at up to 15,000 samples per second. The system converts analog information to equivalent digital form and records it on magnetic tape in either binary or binary-coded-decimal mode.

Circle No. 201 on Subscriber Service Card

**POWER PACK** — Electronic Research Associates, Inc. has published a catalog sheet covering its expanded line of Hypac Miniaturized High-Voltage Solid-State Power Packs. This catalog sheet provides full descriptive and specification data on miniature types with voltage outputs starting at 1000 VDC and extending to 20,000 VDC. Regulated as well as non-regulated units, operating from either a-c or d-c inputs, are described.

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## NASA

- \$3,996,129—Delectronic and Missile Facilities, Inc., New York City, for construction of central lab and office building, Marshall SFC, Huntsville, Ala.
- \$2,980,000—General Co., Computer Dept., Phoenix, Ariz., for services for computing mission at Marshall SFC.
- \$300,000—Sieglar Corp., New York City, from Goddard SFC, for design and construction of complete video system (spaceborne and ground) for operation 250 miles above the earth.
- \$217,000—Mt. Vernon Research, Alexandria, Va., for services and materials for space environmental chamber at Langley Research Center.
- \$66,370—Ferguson Corp., Newport News, Va., for services and materials for building addition and installation of components for the 2000 KW arc jet.
- Cook Electric Co.'s Technological Center Div., Morton Grove, Ill., from NASA and University of Wisconsin, for design, development and fabrication of University's experiment package of the *Orbiting Astronomical Observatory*. No amount disclosed.

## MISCELLANEOUS

- General Vacuum Corp., Medford, Mass., from Radio Div., Bendix Corp., for design and manufacture of ultrahigh-vacuum facility to simulate altitudes equivalent to a pressure of  $1 \times 10^{-8}$  torr or higher. No amount disclosed.
- NAVY**
- \$11,160,093—Johns Hopkins University, Silver Spring, Md., for continued research on *Bumblebee* missile, *Transit* navigation satellite and other research projects.
- \$7,600,000—Range Systems Div., Chance Vought Corp., subsidiary of Ling-Temco-Vought, for two years' operation and maintenance work for Pacific Missile Range.
- \$6,300,000—Motorola, Inc., Chicago, for sonobuoys.
- \$5,000,000—Hughes Aircraft Corp., Culver City, Calif., for production of guidance systems for the *Polaris* missile.
- \$5,000,000—Raytheon Co., Waltham, Mass., for research and development of *Polaris* missile system.

- \$4,500,000—Lockheed Missile and Space Co., Sunnyvale, Calif., for production of *Polaris* missile repair parts.
- \$4,030,782—Thiokol Chemical Corp., Bristol, Pa., from BuWeps, for production of packaged liquid-propellant rocket engines for *Bulldog* missiles.
- \$3,200,000—Raytheon Co., Lexington, Mass., for design, development and construction of two air-search radar sets.
- \$1,994,249—Westinghouse Electric Corp., Sunnyvale, Calif., for research and development on *Polaris* missile-launching system.
- \$1,496,600—General Electric Co., Pittsfield, Mass., for spare parts for *Polaris* missiles.
- \$1,401,349—Lockheed Electronic Co., Lockheed Aircraft Corp., Plainfield, N.J., for planning and installing hydrophones at sea.
- \$1,284,250—North American Aviation, Inc., Canoga Park, Calif., for JATO rocket motors.
- \$1,135,000—Control Data Corp., Minneapolis, for a Model 1604 computer and a 1607 magnetic tape unit.
- \$1,132,370—Elgin National Watch Co., Los Angeles, for fuzes for *Bulldog* missiles.
- \$1,000,000—Farmers Tool & Supply Corp., Denver, for wing assemblies for *Sidewinder* missiles.
- \$800,000—Belock Instrument Corp., College Point, N.Y., from General Dynamics/Pomona, for manufacture of precision instrumentation for use in *Tartar* and *Terrier* missile programs.
- \$230,000—Cedar Engineering Div., Control Data Corp., Minneapolis from Raytheon Co., for *Sparrow III* missile components.
- Baird-Atomic, Inc., Cambridge, Mass., from Applied Physics Laboratory, Johns Hopkins University, for scientific study in connection with *Transit* navigational satellite program. No amount disclosed.
- Telecomputing Corp., Los Angeles, from Lockheed Missiles and Space Co., for development and manufacture of automatically-activated primary battery to furnish in-flight electrical power for *Polaris* A3 guidance system. No amount disclosed.
- Guidance Technology, Inc., Santa Monica, Calif., from Martin, Orlando, for spring-driven gyros for use in *Bulldog* missile. No amount disclosed.

## ARMY

- \$65,802,655—Avco Corp.'s Electronic & Ordnance Div., Evendale, Ohio, for AN/VRC-12 series of radio receiver-transmitters.
- \$8,000,000—Ford Motor Co., Aeronautics Div., Newport Beach, Calif., for continued development of *Shillelagh* missile system.
- \$314,700—Sylvania's Electronic Defense Laboratories, Mountain View, Calif., for design and prototype production of electronic warfare equipment.

## AIR FORCE

- \$6,900,000—Douglas Aircraft Co., Santa Monica, Calif., for development of a capability for air-to-air rocket fuze production.
- \$3,700,000—Lockheed-Georgia Co., Marietta, for machine tool modernization.
- \$2,517,000—Massachusetts Institute of Technology, for continuation of work at Cambridge on a high-field magnet laboratory.
- \$2,500,000—General Dynamics, Ft. Worth, for development of design criteria for nuclear-powered aerospace systems.
- \$2,300,000—Sylvania Electric Products, Inc., Dayton, Ohio, a subsidiary of GT&E, for development and manufacture of magnetrons and klystrons.
- \$1,933,724—The Compudyne Corp., Hatboro, Pa., for fabricating sets of hydraulic systems for a *Titan II* facility.
- \$1,900,000—Kollsman Instrument Corp., Elmhurst, N.J., subsidiary of Standard Kollsman Industries, Inc., for automatic astro compasses.
- \$1,089,000—Columbia University, New York City, for research in mid-course identification and tracking of ballistic objects.
- \$1,002,830—Bomac Laboratories, Inc., Beverly, Mass., for production of electron tubes for classified projects.
- \$650,000—General Electric's Defense Systems Dept., Syracuse, N.Y., for initial spare parts for MISTRAM.
- \$467,200—Allison Div., General Motors Corp., Indianapolis, from Aerojet-General Corp., for titanium second-stage rocket engine cases for *Minuteman ICBM*.
- Solar Aircraft Co., San Diego, from Aeronautical Systems Div., for development, fabrication and testing of aerospace vehicle front sections. Lockheed Missiles and Space Co. will perform trajectory and structural analysis. No amount disclosed.
- Sperry Gyroscope Co., Great Neck, N.Y., for a study to determine what new electronic countermeasures techniques may further ensure that U.S. missiles can penetrate enemy radar defenses. No amount disclosed.

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Molybdenum  
Tantalum  
and  
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## when and where

### OCTOBER

National Conference on Industrial Hydraulics, Versatility and Reliability of Fluid Power, Sherman Hotel, Chicago, Oct. 19-20.

East Coast Conference on Aerospace and Navigational Electronics (ECCANE), Lord Baltimore Hotel, Baltimore, Oct. 23-25.

IRE Aero-Space Nuclear Propulsion International Symposium, Las Vegas, Nev., Oct. 23-27.

Bi-annual U. S. Air Force Interceptor Weapons Meet (William Tell 1961), Tyndall AFB, Fla. Oct. 23-Nov. 3.

Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Oct. 23-24.

URSI-IRE Fall Meeting, University of Texas, Austin, Oct. 23-25.

Fifth Annual Varian Nuclear Magnetic Resonance-Electron Paramagnetic Resonance Workshop, Stanford University, Palo Alto, Calif., Oct. 23-27.

43rd National Metal Congress, sponsored by American Society for Metals and eight participating organizations, and 1961 Detroit Metal Show and ASM Materials Comparison Center, Cobo Hall, Detroit, Oct. 23-27.

Bi-Annual U.S. Air Force Interceptor Weapons Meet (William Tell 1961),

Tyndall AFB, Fla., Oct. 23-Nov. 3.

National Association of Corrosion Engineers, South Central Regional Meeting, Shamrock Hilton Hotel, Houston, Oct. 24-27.

International Symposium on Aerospace Nuclear Propulsion, AEC, NASA, IRE, Riviera Hotel, Las Vegas, Nev., Oct. 24-26.

1961 Computer Applications Symposium, sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Oct. 25-26.

National Management Association, 1961 Annual Conference, Sherman Hotel, Chicago, Oct. 25-27.

Instrumentation Facilities for Biomedical Research Symposium, Sheraton Fontenelle Hotel, Omaha, Oct. 26-27.

1961 Electron Devices Meeting, IRE, Sheraton Park Hotel, Washington, D.C., Oct. 26-28.

1961 Aero/Space Fluid Power Conference, Seminar sponsored by Aero Hydraulics Division of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 30-31.

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# Enough of This Non-Profiteering

**V**ICE PRESIDENT JOHNSON has just concluded a morale-boosting jet tour of missile/space installations in the West. These included NASA's Ames Research Center near San Francisco, Edwards AFB, Jet Propulsion Laboratory, Vandenberg AFB, the Pt. Arguello facility of the Pacific Missile Range, and the Aerospace Medical Center in Texas.

This indication of top-level interest in the working base of the nation's space program is heartening, not only to those employed at the bases visited, but to everyone connected with the program.

We are pleased to hear that such visits will continue. As head of the Space Council, the Vice President is, of course, directly concerned with the space program and the problems it encounters. His decision to gather his information first-hand most certainly is to be commended.

But the most immediate benefit of the tour was its quite discernible effect on morale.

"We have lots of visits from program directors," a JPL scientist told our West Coast bureau chief, Dick van Osten, "but this is the first time anyone from this echelon of the government has visited us. We need and appreciate it."

The enthusiasm over the Vice President's visit was evident in the NASA briefings, which at times slipped into hearty and undisguised salesmanship.

"We're proud of what we're doing," an Ames Research Center engineer said. "If we're selling too hard, it's because we believe in what we're doing and want the people who pay for it to know about it."

Vice President Johnson surprised several of his briefees with the questions he asked.

"He has a fine grasp of what's going on in our areas," a JPL engineer said, "considering all the other things he has to worry about."

Johnson, in his talks with NASA personnel, stressed the importance of the nation's efforts in space and President Kennedy's own intense personal interest in the space program. The Vice President's words and his own sincere interest produced a strongly favorable reaction at all echelons.

As bureau chief van Osten reports, "Enthusiasm is one thing and progress something else in space programs, but Johnson's trip undoubtedly will pay off."

While we are pleased with the enthusiasm generated by the Vice President's trip, we are less than happy with some of the news emanating from the tour. We are referring to newspaper reports that NASA is planning to set up yet another non-profit corporation, this one to help run the space program.

Civil service salary scales certainly are a problem, as the Vice President learned on his tour. He was deeply impressed by the difficulties NASA has in

holding top-notch scientists and engineers against the lure of higher-paying jobs in industry.

But we are disappointed at the suggestion that another non-profit firm is a necessity. Such an organization could take one of two forms—neither of which offers strong appeal. It could be set up along the lines of Aerospace Corp. as a scientific-technical organization to provide program management and/or technical evaluation. If this is contemplated, one question immediately arises. Why not use Aerospace Corp.? Aerospace was, of course, established primarily for the benefit of the Air Force and its first acceptance of a small NASA contract met with strong Air Force opposition.

The Air Force should be told to go suck its thumb elsewhere. If Aerospace can be useful to NASA, it should be so employed.

The other non-profit approach would be to set up a group similar to the Institute for Defense Analysis employed by the Department of Defense to get some high-priced talent for the Pentagon. Under this concept, the non-civil service talent would be spread throughout NASA; the corporation itself would be merely a dummy organization.

The problems such an "elite corps" would create can easily be imagined.

**WE WOULD LIKE** to make a few suggestions.

Non-profit corporations are proliferating at a great rate. Deputy Defense Secretary Roswell Gilpatric announced in New York the other day that the Pentagon is about to create another one—to study ways of improving military procurement. If civil service salary scales really are so bad that no worthwhile talent will remain with the government, perhaps a new look at government pay scales is in order. Otherwise, we shall be up to our navels in non-profit corporations in a very short time.

Second is the fact that, properly motivated, many people of very considerable talent have in the past and will in the future work for the government despite the offer of higher-paying outside jobs. Indications of appreciation and interest such as the Vice President's just-concluded tour do much to provide that motivation.

But the third and most obvious answer to the problem is this: If industry, due to its higher wage-scale, has the talent needed, then let industry do the job.

Administrator James Webb has said NASA will rely heavily on industry in the space program. We hope he holds firmly to that philosophy.

Another non-profit firm we can do without.

**William J. Coughlin**



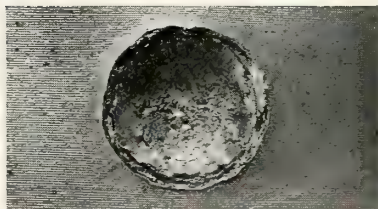


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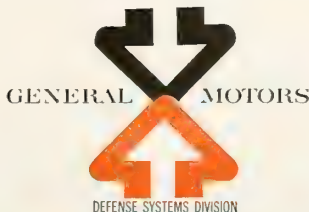
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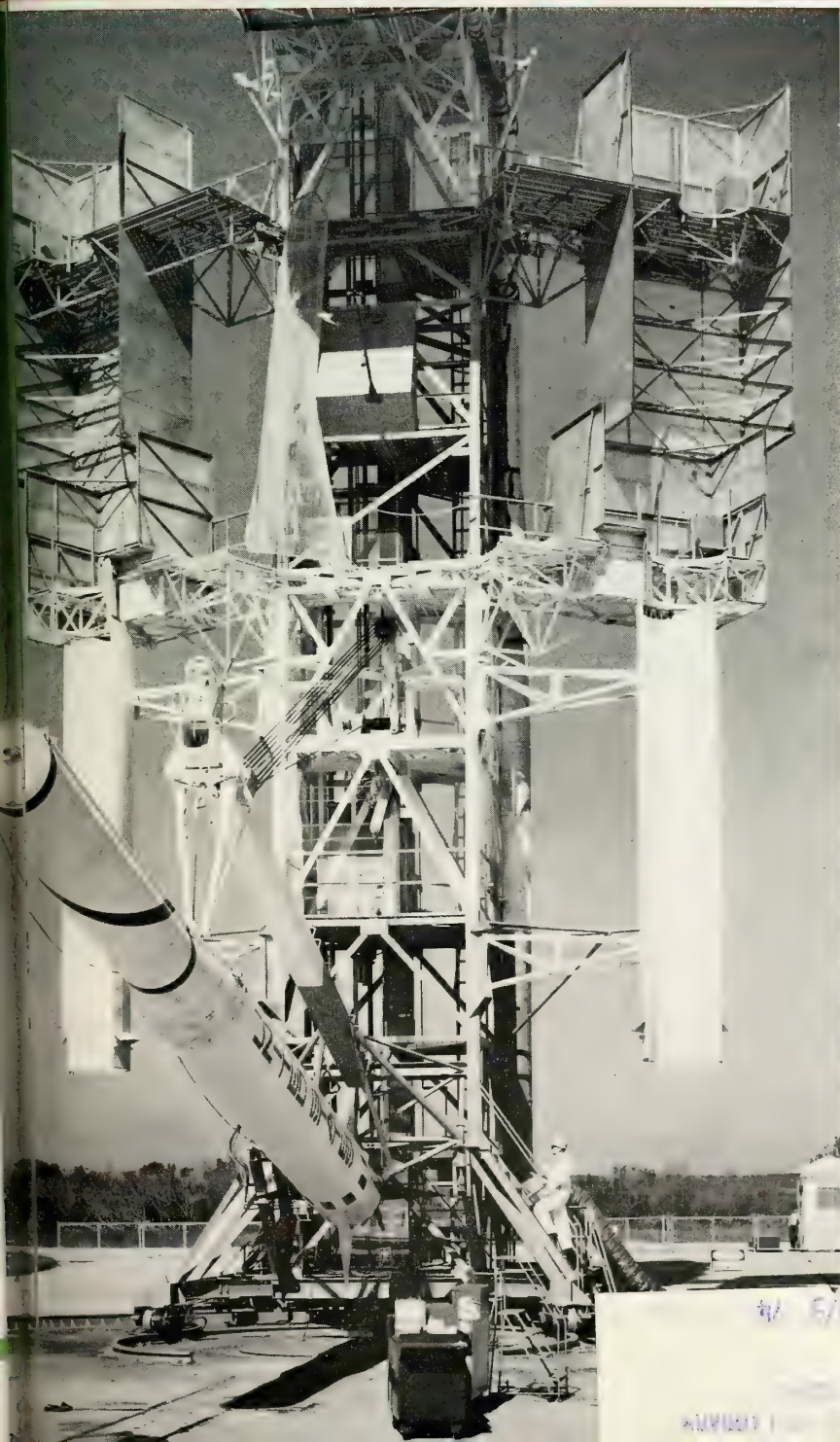
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# missiles and rockets

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THE MISSILE SPACE WEEKLY



## AEC Discloses Preliminary Details of Vela Hotel

- **Major Shift  
In Apollo Studied**
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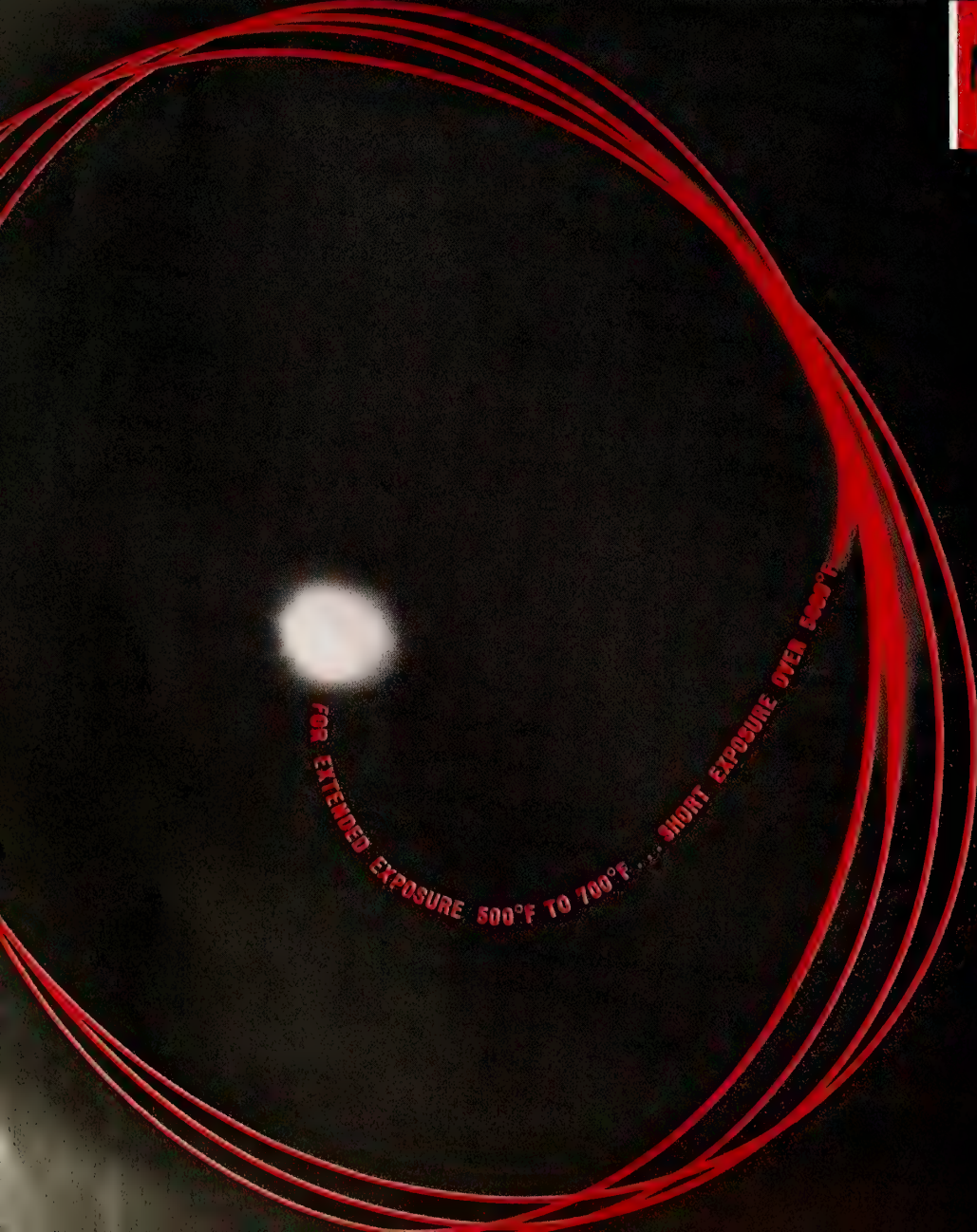
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| Infrared 7/5/61<br>detection eqpt. for<br>Midas Satellites                                                                                                                                                      |  | Electronics Corp. of America<br>One Memorial Drive<br>Cambridge, Mass.                                                                                                                                                                                                          |  | Lockheed Aircraft Co.<br>Missile Systems Div.<br>P.O. Box 504<br>Sunnyvale, California                                                                                  |  | Infrared detection 7/5/61<br>eqpt. for Midas Satellites |  |
| CONTRACT DESCRIPTION                                                                                                                                                                                            |  | RECEIVING CONTRACTOR                                                                                                                                                                                                                                                            |  | AWARDING AGENCY OR CONTRACTOR                                                                                                                                           |  | CONTRACT DESCRIPTION                                    |  |
| Elec. Corps. of Amer.<br>Memorial Drive<br>Cambridge, Mass.                                                                                                                                                     |  | TO: _____                                                                                                                                                                                                                                                                       |  | F-S CATEGORY<br>NUMBER EW 31                                                                                                                                            |  | CONTRACT SIZE \$2,000,000                               |  |
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| AWARDING AGENCY<br>OR CONTRACTOR                                                                                                                                                                                |  | <input type="checkbox"/> PHONE <input type="checkbox"/> TELEGRAM <input type="checkbox"/> TELETYPE <input type="checkbox"/> ON BACK                                                                                                                                             |  |                                                                                                                                                                         |  |                                                         |  |
|                                                                                                                                                                                                                 |  | OTHER INFORMATION<br>This is a letter contract award announced 7/5/61 expanding FCA's participation in the MIDAS satellite program. Purchasing agent is Herbert Prebble. The Lockheed Prime contract was awarded by the Air Force Ballistic Missile Division of Vandenberg AFB. |  |                                                                                                                                                                         |  |                                                         |  |
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## missiles and rockets

Volume 9, Number 17

October 23, 1961

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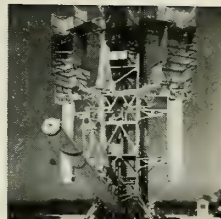
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## THE COVER

NASA's Scout 7 is prepared at Wallops  
Island, Va., for last week's scheduled shot  
carrying a P-21 satellite designed to mea-  
sure electron concentration. See p. 11.



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†U.S. Reg. Pdg.

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## What is the moon made of?

No. Guess again.

Potassium, uranium, thorium? Closer, but still guesswork. And guesses they'll be until man puts scientific instruments on the Moon to gather surface and sub-surface data and transmit these data to Earth.

The right answers will come with unmanned lunar spacecraft projects directed by Caltech's Jet Propulsion Laboratory for the National Aeronautics and Space Administration.

The planned Lunar Exploration Program begins with JPL's Ranger Project that will soon hard-land 50-pound instrument packages on the Moon to measure Moon quakes and temperature and radio their findings back to Earth.

Following the Ranger, the Surveyor will *soft-land* several hundred pounds of sensitive instruments on the Moon. Its objectives are to measure the physical properties of the Moon and

analyze the composition of surface and sub-surface samples. Knowledge from these projects is essential to eventual manned landings on the Moon.

Under JPL direction, unmanned spacecraft for these probes and probes to the planets are being designed. Many disciplines are involved. Physics, electronic engineering, metallurgy, a long list.

It's a big job. To do it right, JPL must have the best technical people in the country. People who want to know. People who want to be part of the greatest experiment of mankind. If you are that kind of people, JPL is your kind of place. Write us.

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## letters

### Tug of War

To the Editor:

An article on page 15 of M/R, Oct. 9 covered the visit of Vice President Johnson on the West Coast. To keep the record straight, I would like to inform you that Mr. Johnson did not visit the Vandenberg AFB facilities; rather he was hosted by Navy and NASA personnel on a visit to the Navy's Point Arguello missile base where NASA is financing the installation of launching, tracking and logistics facilities for its space programs.

Many events led up to why the Vice President visited the Navy rather than the Air Force base. However, the exact truth is that a virtual tug of war occurred between the two groups vying for the attention of the VIP after he landed at the Air Force strip. It seems that the groups were lined up on each side like football teams, each with a long string of cars. When he stepped from the plane an Air Force general grabbed Mr. Johnson and tried to spirit him into an Air Force sedan, but a lowly Navy commander, assigned to NASA, saved the day by thrusting a prepared, printed itinerary into Mr. Johnson's face. After a moment of hesitation, the VIP decided to go with the NASA-Navy contingent.

As a taxpayer, I think the whole thing is foolish and believe that the government personnel involved should try to act like grown-ups and should try to follow the spirit of the President's desires—that is, full cooperation and unification of defense and scientific government agencies.

A Disgusted Civil Service Employee  
Oxnard, Calif.

*This is an interesting addition to M/R's story, which was written before the Vice President's landing at Vandenberg.—Ed.*

### USIS Space Information

To the Editor:

In your Sept. 4 issue, in the Letters to the Editor column, you carried a communication from a Mr. Berte concerning his claimed inability to obtain from USIS Trieste information about U.S. astronautical developments.

Last winter, USIS Trieste put on a series of lectures entitled "Man and Space." This was a seminar of four lectures which began with man's first encounter with space as a mathematical concept down to present-day exploration and tomorrow's exploitation of space. The lectures were on the highest level, with speakers from among Italy's foremost scientists. The same series, which drew upon USIS-supplied films and was supported by USIS pamphlets, was repeated in Padua, Venice and elsewhere. The series drew larger crowds than any (other) lecture sponsored by USIS Trieste during the past two years.

USIS Trieste distributed literally thousands of copies of different pamphlets on the subject and thousands more after the

Shepard flight. USIS Rome supplied Italian TV with an exceptional color film on the Shepard flight. This was seen by an estimated 10 million viewers and was acclaimed in headlines which were repeated in newspapers as far away as Spain. USIS displayed the Shepard capsule in Rome, where 1,200,000 persons saw it in 15 days. Additional millions saw USIS exhibits on U.S. space achievements which were placed throughout Italy.

The letter to the editor makes reference to putting on a lecture series in Yugoslavia. I doubt that USIS Trieste would deny any serious lecturer material on U.S. space achievements unless it was felt that the lectures were destined for a Yugoslav audience and that material in Serbo-Croat could best be supplied by USIS Belgrade. Our relations with Dr. Guido Zecchin, Italian Consul General at Capo d'Istria, have always been cordial. Certainly he would understand that USIS Italian-language material cannot be used in Yugoslavia.

Aside from our science bulletin and special articles for the Italian press, USIS Trieste distributed the following pamphlets solely in connection with showing of the capsule *Freedom 7* in Italy:

10,000 reprints from the July, '60, issue of the *National Geographic* article "Exploring Tomorrow."

1000 *Tiros* pamphlets.

1000 *Echo*.

1500 *Exploring Space Project*.

4000 *MR-3* pictorial brochure, plus 10,000 copies of the pamphlet "My Flight into Space" by Shepard.

15,000 copies of USIS-produced pamphlet on U.S. satellites.

50,000 copies of "Project Mercury."

3000 copies of "The Shepard Enterprise."

Lowell Bennett

Director

Office of Public Information

United States Information Agency

Washington

### Oceanographic Instruments

To the Editor:

Your article entitled "U.S. Seeks Oceanography Instruments" (M/R, Aug. 28, p. 22) has come to our attention. As a result of this article, several companies have written us requesting certain other information.

Since the purpose of our Symposium was to alert industry to our needs, we appreciate very much the fact that your article has extended the effectiveness of this meeting.

Julius Rockwell, Jr.

Coordinator

Government-Industry Oceanographic

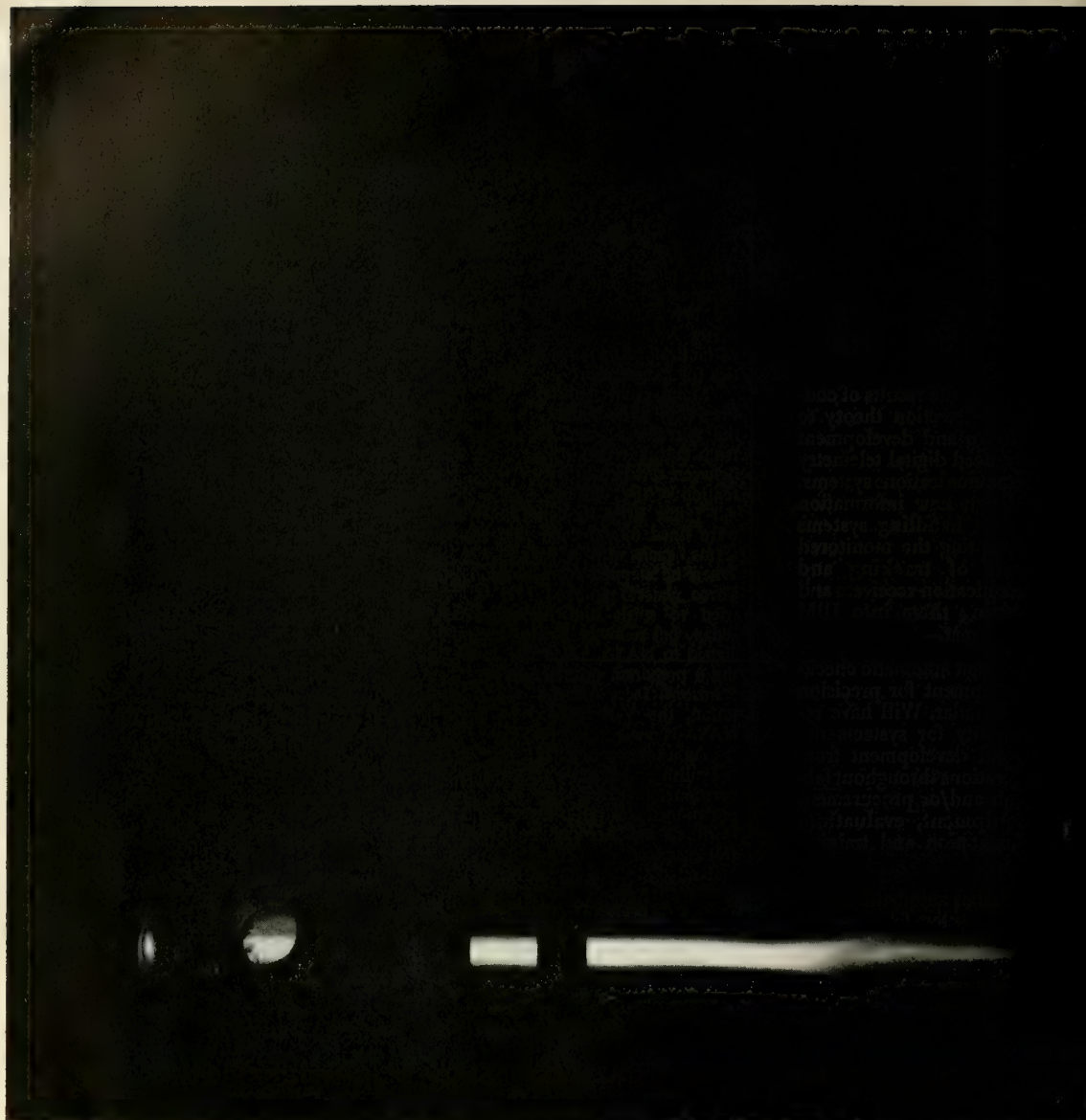
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## WHAT'S SO HOT ABOUT THIS 3 LB. THRUST

It is a plasma jet, formed at more than 18,000°F., and accelerated in a magnetic field to triple its specific impulse. It is being developed in Northrop's Space Propulsion Laboratory as a propulsion system for maneuverable satelloid vehicles and spaceships. Its measured 3-pound thrust and high efficiency make it a leading candidate for the first true space drive.

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types of propulsion. By looking at this theoretic problem from a solid, engineering point of view, Northrop bids fair to revolutionize space propulsion.

Northrop's approach to magnetogasdynamics is reflected in almost every phase of space technology. Wherever men, machines and space are coming together, Northrop techniques and experience are helping to find solid, practical answers.

# NORTHROP



# The Countdown

## WASHINGTON

### Legatons on the Moon?

On the basis of various hints in Soviet technical publications over the last several years, some U.S. space experts are speculating that the 50-megaton nuclear test scheduled by Russia for next week will take place on the moon. Launch vehicle could be one of the new superboosters the Soviets have been testing over the Pacific. Even if they don't try for the moon, the Soviets are expected in some quarters to set off their 50-megaton blast in space.

### ew Life for the X-15?

The Air Force is understood to be pushing a plan for using advanced models of the X-15 rocket plane to train "aerospace pilots." The higher-performance models would operate at 50-100 mi., perhaps be launched from the Cape or Eglin AFB. As matters stand now, the whole X-15 program is scheduled to be wrapped up in about 18 months—leaving a gap before the introduction of the first *Dyna-Soars* in 1963 or 1964.

### rch for Apollo

Data gathered by NASA on micrometeorites and other cosmic phenomena is still so sketchy as to be virtually worthless in the design of the *Apollo* spacecraft. Some satellite and space probe results are said to vary by a factor of four. Accordingly, NASA is expected in the next six months to expand its meteorite investigations—including a major probe using a *Thor* booster next spring.

### ice Changes

COUNTDOWN hears Dr. John P. Hagen, former *Van-guard* director and more recently head of NASA's now-defunct Office for U.N. Conference on Peaceful Uses of Outer Space, will take a new post in NASA's Office of Program Planning and Evaluation. He will become deputy to OPPE Director Abraham Hyatt. . . . James P. Pyle, deputy administrator of the Federal Aviation Agency under the Eisenhower Administration, will head up the Washington Office of General Precision Equipment Corp. starting Dec. 1.

### Dyna-Soar in Pentagonland

The Air Force's much-studied, much-discussed, much-adjusted *Dyna-Soar* plods onward in the swamp of Pentagon debate as to its future. The Air Force Systems Command is promising to submit a new proposal for an acceleration within the next three weeks. Defense Secretary Robert McNamara continues to ponder the more than \$80 million extra voted by Congress for the program. And a number of officials close to the program feel the status quo will prevail.

## INDUSTRY

### Big Delta Buy

NASA will announce this week a contract to purchase 14 more *Delta* boosters from Douglas Aircraft Corp. for \$19 million—bringing the total ordered to 26. The *Delta* is a three-stage launch vehicle comprising a *Thor* first stage, an Aerojet *Ablestar* second stage and a solid third stage by Allegany Ballistics Laboratory.

### ComSat Pricetags

Industry estimates put the cost of medium-altitude communications satellites at from \$450,000 to \$600,000 apiece; high-altitude synchronous ComSats from \$1-2 million. Booster costs, including launch facilities and tracking, would run from \$9.5 million for an *Atlas Agena* to \$10.5 million for *Atlas Centaur*.

### Kerr's Figure: \$30 Billion

Taking the middle of the road, Senate Space Committee Chairman Robert S. Kerr estimates space spending over the next 10 years at \$30 billion. This is midway between the \$20-40 billion other government prognosticators have said will be spent in the decade to put an American on the moon.

## INTERNATIONAL

### An R&D Cost-Sharing Plan

Top British defense officials are understood to be approaching the U.S. and other allies with a "share-the-cost" plan for the R&D of new weapons beyond 1965. The objective: eliminate wasteful (and costly) duplication of effort such as the competition between *Blue Water* and *Sergeant*. The British hold the view that by 1965 most weapon systems will be so expensive it would be foolish to maintain competition on both sides of the Atlantic.

### Overseas Pipeline

Many Europeans appear convinced that Khrushchev has already arrived at a decision not to go to war over Berlin. . . . The Berlin Crisis has not precipitated any new orders in France for tactical missiles (lead time needed to crank up faster production: about 16 months). . . . Nord Aviation has finished development of the 3.7-mi.-range *SS-12* (being proposed for ground-to-sea coastal defense and as armament for small ships, as well as an antitank weapon) and is awaiting production orders.

### RAF's Word on AS-30 Due

A decision is expected this month by Britain's Royal Air Force whether to buy Nord's air-to-surface *AS-30*. The long-overdue decision is snagged by the Royal Navy's preference for the Martin *Bullpup*, and an apparent Defense Ministry determination to buy one missile for both services.

# The Missile/Space Week

## Atlas Force Increases

SAC's combat *Atlas* force rose to 48 missiles this week with the addition of the 548th Strategic Missile Squadron at Forbes AFB, Kan.

This is approximately equal to the number of operational Soviet ICBM's, according to newly revised intelligence estimates.

The estimates were revised downward. They have been seriously questioned by a number of officials.

Even as Forbes went operational, Labor Secretary Arthur Goldberg reported that work stoppages at U.S. ICBM sites increased sharply in September.

He said the increases were due mainly to "unauthorized walkouts" at the *Titan I* sites near Lowry AFB, Colo., and the hardened *Atlas* silo sites near Schilling AFB, Kan.

## Davy Crockett Abroad

The Army's newest tactical missile—the nuclear-tipped *Davy Crockett*—is understood to be already in the hands of U.S. troops guarding the Russian invasion route in Central Europe. However, the missile won't be declared officially operational in Europe until December.

## Shots of the Week

The Soviet Union fired another superbooster 7500 miles from a launch pad in central Russia into the mid-Pacific on Oct. 16. It was the fifth in the current series of tests, which the Russians are extending through the end of this week.

In the U.S.:

- The Air Force air-snatched a 300-lb. *Discoverer XXXII* capsule near Hawaii on Oct. 14. The capsule was ejected after one day in orbit and contained several experiments to determine the effectiveness of various metals in shielding radiation.

- The Navy's largest nuclear-powered FBM sub, the 410-ft. Ethan Allen, successfully launched its first *Polaris* Oct. 16 while submerged 200 mi. off the Cape. Range of the missile was not disclosed.

- NASA Oct. 18 fired a partially-filled bottle of liquid hydrogen to an

altitude of 95 miles aboard an *Aerobee-Hi* to test behavioral characteristics under zero-g.

- The test from Wallops Island, Va., was preceded on Oct. 14 by a preliminary shot of an *Argo D-4* rocket in the U.S.-Canadian ionosphere satellite program. The payload attained an altitude of 560 mi. and landed 800 miles offshore.

## X-15 Soars to Record

The North American *X-15* roared to a new record this week of 3920 miles an hour.

The flight with test pilot Joe Walker at the controls broke the old record of 3647 miles an hour that he set only a week earlier.

Walker flew the *X-15* at 110,000 feet at he streaked over the California desert near Edwards AFB. He set his old record while flying at a record altitude of 217,000 feet.

## Saturn Debut Deferred

NASA has indefinitely postponed the first launch of the *Saturn* superbooster originally scheduled for Oct. 21.

Officials said the shot would be delayed at least a week—and perhaps a month.

The delay was ordered when tests being performed on a *Saturn* on the dynamic test stand at the Marshall Space Flight Center indicated change in the booster's control system would improve flight performance.

The changes involve the motion-sensing elements which feed information into the control system.

Officials said the test-stand data was being analyzed by computer and that a final decision as to what changes are necessary and a new launch date will be made this week.

## Seven Try for S-1 Award

Seven missile/space firms have entered bids on the contract for development of the *S-1* stage of the *Saturn* superbooster.

The seven firms are Ling-Temco-Vought, Boeing, Chrysler, Ford Aeronutronic, Avco, Northrop and Lockheed.



## 200-Ton Telescope

NOW READY for use at Hat Creek, Calif., is this 85-ft. radio telescope, built by Philco for the University of California.

The selected firm will build at least 10 of the eight-H-1-engine-powered stages under the multimillion-dollar contract. NASA invited firms to bid on the contract, which will be awarded next month.

NASA also announced that firms have picked up proposals to bid on the contract for the *S-1<sup>b</sup>* stage of the *Saturn* booster. This stage will have either two or four F-1 engines developing either 3 million or 6 million lbs. thrust.

Bids are due on Nov. 8 and contract will be awarded in December.

The 17 firms are Aerojet, American Machine and Foundry, Avco, Boeing, Ling-Temco-Vought, Chrysler, Douglas, Ford Aeronutronic, General Dynamics/Astronautics, General Motors, Hayes Aircraft, Lockheed Martin, North American, Packard Bell Electronics Inc., Space Technology Laboratories, and Radio Corporation of America.

## West Ford Launch Set

Project *West Ford* was set for launch from Pt. Arguello, Calif., this week aboard the Air Force *Midas*



experimental satellite.

The piggyback *West Ford* package and the satellite for infrared detection of ballistic missile launches were to be boosted into polar orbit by a modified Convair *Atlas D* with a Lockheed *Agna B* second stage.

Unrelated functionally to the *Midas*, the *West Ford* package was to weigh 75 lbs. of copper dipoles in space.

Final go-ahead for controversial project *West Ford* came from a special panel of the President's Science Advisory Committee.

The minute filaments are expected to form a narrow band around the earth in about two months. They will be employed in an experiment to determine the feasibility of using such filaments in long-range communications. Lifetime of the thousands of dipoles in the 2360-mi. orbit is estimated at seven years.

Following recent protests from the International Astronomical Union and the Soviet Academy of Sciences, Dr. Jerome Wiesner, science advisor to President Kennedy, decided to have a special panel take still another look at the project. Earlier reports had said the belt would not interfere with astronomical observation.

## P-21 to Study Ionosphere

NASA scheduled for launch last week a P-21 satellite designed to explore physical phenomena in the upper atmosphere.

The satellite will be boosted by a Scout vehicle with four solid stages. P-21, an eight-sided craft, will investigate ionospheric characteristics important in radio communication, radio tracking and guidance.

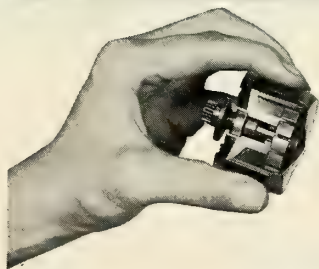
## NASA Good to Small Business

NASA is doing a fine job in helping small business. That's the conclusion of a staff study made for the House Space Committee. The study was based on NASA's procurement report for Fiscal 1961 (M/R, O. 2, p. 16), which said 16% of NASA's R&D money went to small business.

The committee study suggested that NASA should be more certain that contracts do not go to a large firm which wants to start work it is not already equipped to handle, when a small business is available.



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EM-9

# First Details of Vela Hotel

**Satellite for detecting nuclear explosions in space will weigh 300-400 lbs., may be twelve-sided**

by Frank G. McGuire

LOS ALAMOS, N.M. — Preliminary details of the proposed *Vela Hotel* satellite system designed for detection of nuclear explosions in space have been disclosed by the Atomic Energy Commission.

Physical size and shape of *Vela Hotel* satellites will be determined by the contractor, still to be selected. But preliminary work on internal components indicates a satellite weight of some 300-400 lbs. and a diameter on the order of 40 in.

The shape devised by Los Alamos Scientific Laboratory to provide maximum coverage for each detector is an icosahedron. But this 12-sided package will not necessarily be the operational shape.

The number of satellites to be employed in the system has not yet been finally determined, but at least six are required for complete geometric coverage.

One technique which might be used would boost the minimum number to 12. This calls for placing two satellites several hundred kilometers apart in identical orbits, in an effort to eliminate the possibility that a cosmic ray burst within a single satellite could trigger the detectors and cause a false alarm. The bursts may occur at a frequency of several per day in each satellite.

In the proposed two-satellite approach, only if both satellites reported the same "event" simultaneously would the signals received be considered indication of a nuclear detonation.

A concerted effort is being made to insure that *Vela Hotel* is virtually foolproof in its ability to detect illicit explosions without being prone to false alarms.

• **Careful evaluation**—As reported earlier (M/R, Oct. 16, p. 48), the Administration is taking a new look at the system to assure that it still is the most promising method of detecting such explosions. The contract award is being delayed while this study is made.

Total Department of Defense and



SHOWN WITH ICOSAHDRON shape with bulging X-ray detectors (on table) are LASL's Drs. Tascheck and Westervelt.

AEC budget for *Vela Hotel* in Fiscal '62 is estimated at \$12.1 million. The project was funded at \$8.7 million in Fiscal '61. Due to the advanced state of its development, the program is not likely to be transferred to the newly-created U.S. Arms Control and Disarmament Agency (M/R, Oct. 9, p. 12).

Los Alamos Scientific Laboratory, developing sensors and circuitry for the detection portion of *Vela Hotel*, feels there is an excellent chance that accurate distinction can be made between explosions and natural radiation.

Key LASL scientists in *Vela Hotel*'s detector development program include Drs. Richard Tascheck, Donald Westervelt, Harold V. Argo, J. A. Northrop, and James Coon. The *Vela Hotel* group totals about 30. Other laboratory divisions are working on *Vela Sierra*, the detection of nuclear explosions in space through ground-based equipment.

The key to detection of spatial nu-

clear explosion lies in the short, intense burst of rays emanating from the detonation. There will be no visible fireball or blast effect, since these are due to interaction with the atmosphere.

Pending verification of environmental conditions at the desired orbital altitude, *Vela Hotel*, 50,000 miles, LASL points out that the expected X-radiation from a one-megaton weapon detonated at  $3 \times 10^8$  (or twice the) distance from earth to the su-

would yield a signal 100 times larger than that required for certain detection.

This figure is based on laboratory standards, but is viewed as an indication that *Vela Hotel* will have a substantial signal strength to work with.

• **Satellite and equipment**—The configuration of detection and logic systems for *Vela Hotel* has now been frozen, and details of circuitry are being polished by LASL and Sandia Co. The latter is developing the logic associated circuitry for the payload.

(Atomic Energy Commission declined to release any details or general characteristics of the logic equipment for *Vela Hotel*, but information on the detectors is available.)

The LASL portion of the payload will interface with Sandia's portion where detector circuitry enters the package. This package will interface with telemetry units to be developed and supplied by an industry contractor not yet chosen.



The industry contractor will also be possible for the satellite control system, power supply and conversion, and command system. The contractor will be named by USAF's Space Systems Division, the responsible organization working with the Advanced Research Projects Agency, the cognizant agency for *Vela*.

Life expectancy of each satellite is limited at about six months in the early phases of the program. A reliability problem probably will be posed by the very high number of parts in the system, and the total of almost thirty detectors of various types. The R&D missions, however, are more rigid in their tolerances than is expected to be the case with later models. This is primarily due to the large number of unknowns involved and the greater number of electronic problems anticipated.

A small amount of data storage is planned for the first *Vela Hotel* payloads, since LASL hopes to achieve nearly complete real-time coverage of interesting events." The real-time aspect calls for considerable telemetry, as *Vela Hotel* telemetry interference with other programs increases, the real-time coverage will be reduced and a higher-capacity storage system will be employed on board the satellite.

The logic circuitry will then record the most interesting of the suspected events in the preceding time period and put out the information on command to a ground station. If the storage capacity is completely used up before the event, and another highly interesting event occurs, the logic will erase the least noteworthy of those events already recorded, then record the later, more significant, event.

The power for all circuitry aboard the satellite will most likely be supplied by solar cells, since a nuclear power source would set up an intolerable level of gamma radiation near the detectors. Telemetry requirements for the satellite now call for one digital channel and a non-directional antenna. Despite the non-directional antenna, however, the precise position of the satellite must be known.

Redundancy techniques will be used where necessary to insure acquisition of reliable information. This attitude has been maintained throughout the electronic design phases of the payload, and is expected to continue into the data-acquisition phase of the program.

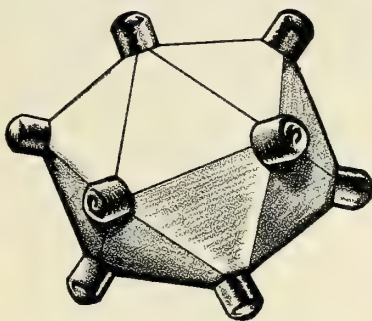
Air Force Space Systems Division will handle data acquisition operations. Effort will be made to acquire data to pinpoint the position of a suspected nuclear detonation. Only the gross direction and precise time within milliseconds will be recorded. Precise timing

will allow close coordination with other detection means in order to add verification.

• **Flight testing** — Several experimental packages have been flown on USAF vehicles by LASL and Sandia, including full-scale prototype satellite systems. The vehicles included balloons floating at altitudes of 120,000 ft., carrying payloads with 12 X-ray detectors or 12 gamma-ray detectors, along with the necessary logic circuitry.

In these payloads, the logic circuitry measures with which high-order coincidences occur as a function of the sensitivity of the detectors. A telemetry link furnishes ground stations with this data, which is then recorded on magnetic tape.

Thus far, coincidences have been caused mainly by cosmic-ray showers,



DRAWING shows detail of LASL's proposed 12-sided *Vela Hotel* satellite.

since X-rays cannot get down to such low altitudes without being absorbed. LASL and Sandia have thereby gained an upper limit on the frequency of high-order coincidences without actually launching a satellite, and have also gotten a year's head-start on logic design for the actual satellites.

One of the most significant flight tests for *Vela Hotel* hardware is being carried out in conjunction with the *Ranger* spacecraft program. In this test, two X-ray scintillation counters on the spacecraft will look at X-rays originating from the sun, in an attempt to verify expected differences in burst-lengths between solar and nuclear-weapon X-radiation.

These counters will examine solar X-rays for about a month, analyzing the flux for short-duration bursts of significant intensity, which solar physics experts feel to be highly unlikely.

The third major experiment in flight testing involves launches aboard an Air Force *Blue Scout Jr.* rocket, in cooperation with the USAF Special Weapons Center at Kirtland AFB, N.M. This package contains two X-ray detectors and two gamma-ray detectors, both looking for short-duration radiation

bursts from the sun.

As LASL's Dr. Tascheck put it: "The most interesting thing we have learned so far is how many things can go wrong with any experimental program involving a rocket."

Actual flight versions of operational *Vela Hotel* satellites will go into circular 50,000-mile orbit aboard *Atlas/Agena-B* boosters supplied by AFSSD.

• **Environment and sensors** — Although there is no concrete evidence indicating the exact X-ray environment at 50,000 miles altitude, previous space probes have indicated that a favorable situation exists for *Vela Hotel* detection equipment to operate effectively.

As a basis for accurate operation, the *Vela Hotel* equipment will look for X-ray bursts of less than one microsecond, the most reliable characteristic of a nuclear explosion in space.

Due to the absence of atmosphere, spatial nuclear detonations will have no flash of visible light, fireball, or blast wave. Instead, over half the available energy will be released in the form of thermal radiation.

The unique aspect of this is that the case temperature of the weapon will be so high that the thermal radiation will be released as X-rays instead of infrared radiation. These X-rays will have between one and five kev of energy, and, because of the extreme temperature of the bomb case (on the order of  $15 \times 10^6$  degrees K), will be radiated in less than  $10^{-6}$  sec.

The shortest burst of X-rays ever measured from the sun lasted 18 seconds. Unless much shorter bursts are found to exist, *Vela Hotel* should have clear sailing.

LASL says it is the intensity and shortness of this burst which constitutes the key to nuclear detection in space. The intensity of the burst will determine range, and a one-megaton weapon detonated at  $3 \times 10^8$  km (twice the earth-sun distance) will deposit 1.5 mev of X-ray energy into each square centimeter of detector area.

It is this calculation, previously noted, which gives 100 times the signal strength necessary for detection, by laboratory standards.

(U.S. experts in the field of nuclear test detection have pointed out that undue optimism at the original Conference of Experts in Geneva was not substantiated by later data, and this blocked agreement on detection of underground explosions. The same fate is not expected to befall space detection methods, however, because of the unmistakable nature of the X-ray "signature" involved.)

The range of *Vela Hotel* detection capability varies, but it can be roughly

(Continued on page 49)

# Air Force May Get Bigger Role In Apollo

**AF gathers support behind argument that military has need for spacecraft—and should be in lunar program**

by James Baar

A MAJOR SHIFT in the scope of the *Apollo* man-to-the-moon program is under consideration at top levels of the Kennedy Administration.

The shift would greatly broaden the program in order to provide the Air Force with much of the capability needed to develop defensive and offensive military spacecraft.

This is the significance behind a series of recent statements by top civilian and military officials warning of the growing Soviet space threat.

Air Force proposals for reorienting the man-to-the-moon program are being studied in the Pentagon and elsewhere in the Administration.

Specifically, these proposals would enable the Air Force to play a far greater role in the program at both the planning and operating levels. They also would place the Air Force's R&D space projects more directly under the surveillance of the National Aeronautics and Space Council.

The argument being put forth by Gen. Bernard Schriever and his Air Force Systems Command falls into two main parts: Military requirements and management.

• **Military case**—AFSC is contending that despite continued doubts in high places in the Administration there are important military requirements for developing the means to control space.

However, AFSC clearly feels that the *Apollo* man-to-the-moon program as now constituted will not be broad enough to provide the technology needed for military space systems. And, to date, the funding to develop this technology under a purely military program has not been provided.

Confronted with this argument, some Administration officials have said that the military technology would "fall out" of the civilian program for use later if needed. The Air Force reply is that this will not happen as the *Apollo* program is now constituted.

As a result, the Air Force is saying that at worst the country is opening itself to a military "technological surprise" in space that could be disastrous. It is saying that at best a crash military program will have to be started later—when the NASA program is found to be too narrow.

The Air Force contends that this can be avoided now by establishing a broad Air Force-NASA manned lunar landing program under a sufficiently broad management.

As Schriever put it earlier this month before the American Rocket Society convention in New York:

"In the past, our space efforts have been carried out under an unnecessary, self-imposed restriction—namely, the artificial division between 'space for

peaceful purposes' and space for military uses. But there is very little technical distinction between the two.

"The same hardware and technique used to launch an orbiting scientific capsule can also be used to orbit an early-warning satellite. The same techniques that can send a man into space as a scientific observer may also send him there in a military role."

• **Team available**—Then, in pointed reference to the problems managing the vast manned-lunar-landing program, Schriever said:

"(The Air Force) has learned techniques of management which permit us to bring new systems into the inventory in a few short years, as we did with our ballistic missiles. There is no short cut to the creation of a team of dedicated and experienced men with a tradition of accomplishment."

"The Air Force has a highly competent team trained in the skills required to develop the necessary military capabilities in space. . . ."

AFSC is insisting that Schriever not saying the Air Force should take over the manned-lunar-landing program, but that it should play a major rather than a very subordinate, role.

Strong opposition to this comes from a number of points.

Some NASA officials fear the scientific programs would be hurt. Other officials, contemplating the expansion of their operations, see an obstacle to the plans.

Even more important opposition comes from the Defense Department, which continues to refuse to accept contention that a military requirement for manned military spacecraft exists.

However, the Air Force has recently found support both at the White House and in Congress.

Dr. Edward Welsh, executive secretary of the National Space Council said recently:

"In my view, we do not have a division between peaceful and non-peaceful objectives for space. Rather we have space missions to help keep the peace and space missions to help increase our ability to live well in peace."

Vice President Lyndon B. Johnson, Space Council Chairman, said less than two weeks ago:

"Space programs have been developed which can apply to both civilian and military space efforts. It is not useful to pretend that arbitrary distinctions should be made between the two."

And in both the House and Senate a number of key congressmen have made clear that they would support huge monetary outlays for space on the grounds that they contributed to the nation's military strength.



o ruling this year . . .

# ComSat Proposal Faces Long Hearings

by Hal Taylor

CONGRESSIONAL and executive activity of an industry proposal to set a non-profit corporation to operate commercial communications satellite system will delay a final decision until 1962.

It has been learned that the Federal Communications Commission will hold a public inquiry into the industry proposal next month. The Senate Minority Subcommittee has already announced that it will hold public hearings on the ownership plan on Nov. 6-8. Three other committees—the Senate Commerce Committee and the Space Committee of both houses of Congress are also expected to get into the act, though no hearing dates have been set. Lengthy hearings, an FCC official says, will postpone a decision until next year.

The renewed and accelerated interest in the first commercial outgrowth of the Space Age stems from a noisy disagreement over the proposal within industry and from government fears that one firm, American Telephone and Telegraph Co., will dominate it.

**Industry proposes**—The industry recommendation was made by an Ad Hoc Committee of international communication carriers, set up by the FCC in July.

The committee proposed that a non-profit corporation be formed to develop and operate the system, which it estimated could be in commercial operation by 1965 (M/R, July 31, p. 17).

Satellites would be jointly owned by international communication carriers using the system. The firms would also own and own their own ground stations. Use of both the satellites and ground stations could be leased to any firm not wishing to participate in their ownership.

The board of directors of the non-profit corporation would have three members appointed by the President of the U.S., two members from each firm participating in ownership of the satellites and one member selected by all the firms leasing the system's facilities. One firm—Western Union Telegraph Co.—filed a minority report in which it cautioned that the corporation might be dominated by one company—obviously referring to AT&T. It called in favor for a public stock corporation. The Justice Department shares the

minority view, and many members of Congress are worried about AT&T control. The FCC favors the non-profit corporation approach, but wants to delve into the reasons behind Western Union's opposition.

**Washington disposes**—The split between the government agencies means that the final decision on ownership of the system will be made by the White House and Congress. Administration officials have been considering alternatives to the Ad Hoc Committee's proposal for the past several weeks. A White House official refused to reveal what alternatives have been considered, except to declare that "at this time, there is no real support within the administration for government ownership of the system."

The Ad Hoc Carrier committee included American Cable & Radio Corp., American Telephone & Telegraph Co., Hawaiian Telephone Co., Press Wireless Inc., Radio Corporation of Puerto Rico, RCA Communications Inc., South Puerto Rico Sugar Corp., Tropical Radio Telegraph Co., United States-Liberia Radio Corp., and the Western Union Telegraph Co.

The committee estimated that the initial capital required to establish a satellite system would run from \$45 million to \$150 million, depending upon the type of system selected. The cost of ground stations—which would be owned by the respective companies—was estimated at \$7.5 million to \$34 million.

**Commitments**—AT&T declared it is willing to contribute \$50 million to the system initially, and an additional \$15 million if it is needed later on.

American Cable and Radio Corp., a subsidiary of International Telephone and Telegraph Co., offered to supply up to \$5 million; Hawaiian Telephone Co., \$2 million; Radio Corp. of Puerto Rico, another IT&T subsidiary, \$800,000. Western Union offered to provide up to 5% of the total cost, but not more than \$5 million.

Two other committee members, South Puerto Rico Sugar Corp. and Tropical Radio Telegraph Co.—said they were unable to contribute toward the cost of the system.

Press Wireless Inc. and RCA Communications Inc., a subsidiary of the Radio Corp. of America, said they were unwilling to make a commitment for a

capital contribution until more research had been done on the type of system needed.

**Pitch for medium altitude**—The committee made no decision as to the best type of satellite communication system. AT&T reportedly favors the medium-altitude orbit system, in which a score of satellites would be placed in either polar or equatorial orbits at altitudes of several thousands of miles.

The committee estimated the cost of 20 medium-altitude satellites in random polar orbit at \$45 million to \$94 million. If 10 additional medium-altitude satellites were placed in a random equatorial orbit, the committee said, the cost might total from \$67 to \$141 million.

The medium-altitude technique requires that each ground station have access to computing and tracking facilities to determine the position of each satellite so it can be followed with directional antennas as it moves into orbit. Ground stations for such a system in the U.S. would cost from \$26.5 million to \$34 million. In foreign countries, the cost would rise from \$45.3 million to \$63 million.

**Consensus for synchronous**—A majority of the committee, however, favored using far fewer satellites and placing them in the technically more difficult "synchronous" orbits at an altitude of 22,300 miles. At that altitude, the speed of the satellite reaches the speed of the earth's rotation, so that the satellite remains fixed in relation to the earth's surface.

The committee's report said that two pairs of these satellites could link the major international communication areas of both hemispheres, and three pairs could cover the inhabited part of the world with considerable overlapping.

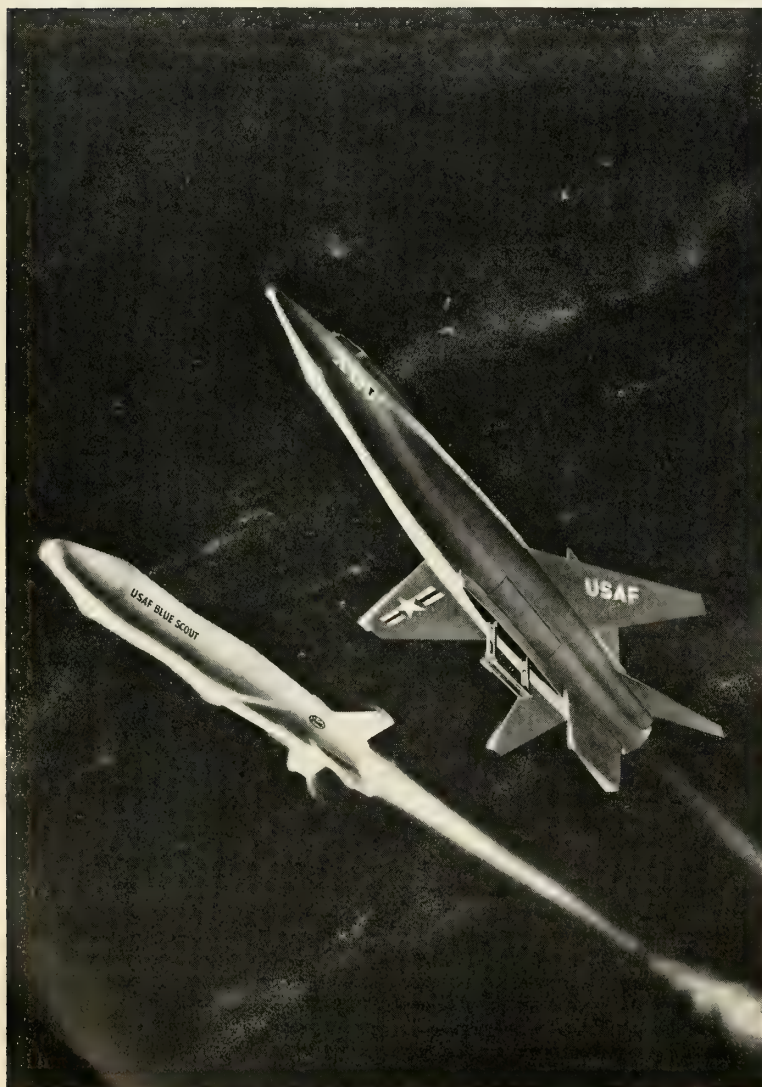
The committee estimated the cost of such a system at \$75 million to \$150 million.

Primary advantage of this system is the cheap cost of ground stations which would have fixed antennas, but no tracking facilities. The ground stations would cost \$7.5 million to \$9 million for U.S. firms and \$17.5 million to \$21 million for other countries. The cheaper cost would probably enable more foreign countries to participate in the system. ■

Available in 9 months . . .

# B-52/X-15 Proposed as Recoverable

**North American and Aeronutronic claim use of planes with Blue Scouts would save \$250,000 per launch, plus GSE costs**



*X-15 LAUNCHES Blue Scout at 156,000 ft. in artist's conception of recoverable booster system proposed by Ford Motor's Aeronutronic Div. and North American.*

THE AIR FORCE is looking over a joint proposal by North American Aviation and Aeronutronic Div. of Ford Motor Co. that the B-52 and X-15 be used as a recoverable booster system for Blue Scout space probe and satellite launchings.

The two companies estimate that using the aircraft as first and second stages would enable savings of up to \$250,000 per launch, or \$12,025,000 on 50 launches employing one modified X-15. This figure takes into account only Blue Scout hardware, not the additional savings resulting from elimination of the entire gantry complex and associated ground support equipment—or the reduced man-hours per launch. Roland P. Bergeron, Aeronutronic project manager for the system to M/R.

NASA's flight research center at Edwards AFB, Calif., was briefed on the idea, but the proposal was made only to the Air Force.

• **Fringe benefits**—In addition to savings, NAA and Aeronutronic list these advantages:

- Increased capabilities for Blue Scout.

- Maximum utilization of present available B-52/X-15 research vehicle systems.

- Advances in state-of-the-art knowledge and experience in recoverable booster technology.

The NAA-Ford team said it could have the system ready for launch in nine months at a total cost of \$850,000—including B-52, X-15 and Blue Scout modification, fabrication of two dummy Blue Scout test vehicles, one Blue Scout flight vehicle, and the cost of development tests. Subsequent launches could be made for less than \$250,000 per flight, Bergeron said, including costs for the Blue Scout rocket and associated checkout and operating costs of the B-52 and X-15.

Guided flights of the X-15/B-52 missiles and rockets, October 23, 1954



# osters

Bill Wilks

ut would utilize the Hercules ABL 58 and ABL X-259 rocket stages. Guided flights would have the ABL 59 and the Aerojet 30 KS 8000 (-10), plus the Naval Ordnance Test ion NOTS 100A, a spherical motor for orbit injection. Weight of the *Scout*, slung under the *X-15*, would range from 3000 to 5000 lbs.

The system would be capable of ing a 50-lb. payload in an 800-n.-orbit, and 100 to 150 lbs. in orbits 50 and 300 n. mi., Bergeron said. The altitudes of up to 100,000 n. mi. could be achieved with "useful payload flights."

For West Coast launchings, *Blue Scout* would be fired out to sea from *X-15*, meaning a 15-lb. drop in capacity since the vehicle couldn't take advantage of the earth's rotation.

**Familiar drill**—Operation of the *X-15* and *Blue Scout* in such launches would differ greatly from current *X-15* flights. The first-stage B-52 would climb around 45,000 ft. with the *X-15* slung under its right wing. Upon release from the B-52, the *X-15* would climb to about 156,000 ft., launch the *Blue Scout*, and coast to 300,000 ft. before beginning its re-entry maneuver.

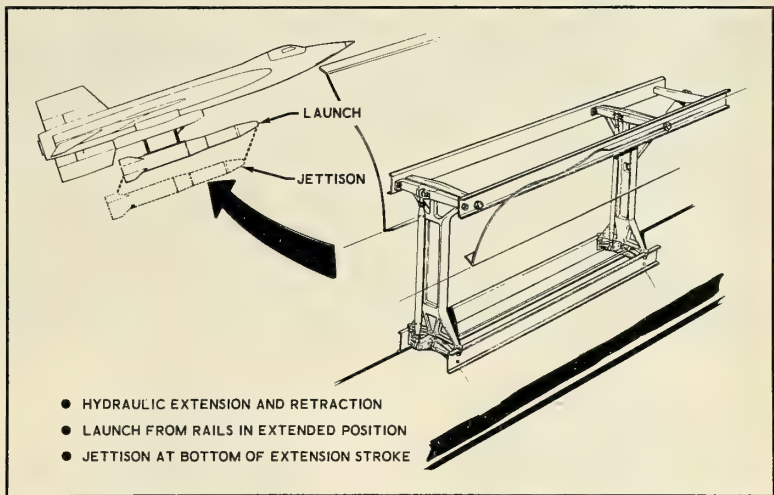
The *X-15* could launch *Blue Scout* at velocities as high as 5400 fps and at angles of 10-60 degrees. Mission requirements for the proposed launches are not critical for *X-15*, NAA says.

The *Blue Scout* launch sequence could be initiated by the *X-15* pilot or by command from the test director sitting at a checkout console in the B-52.

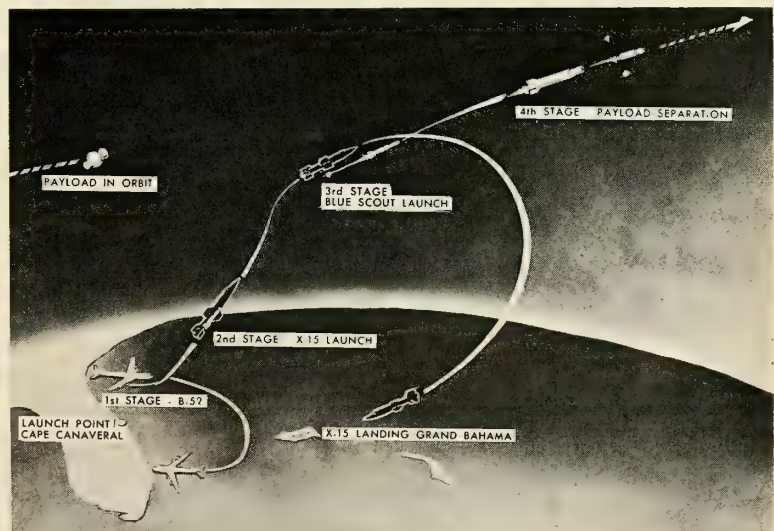
Main *X-15* modifications would include installation of a 500-lb. retractable launch pylon and realignment of its thrust vector down to 30 degrees 30 minutes from its present position to compensate for the change in center of gravity. *Blue Scout* modifications would include enlarging the engine dynamic fins.



MODEL of X-15/Blue Scout system is studied by Ford Motor president John Dykstra.



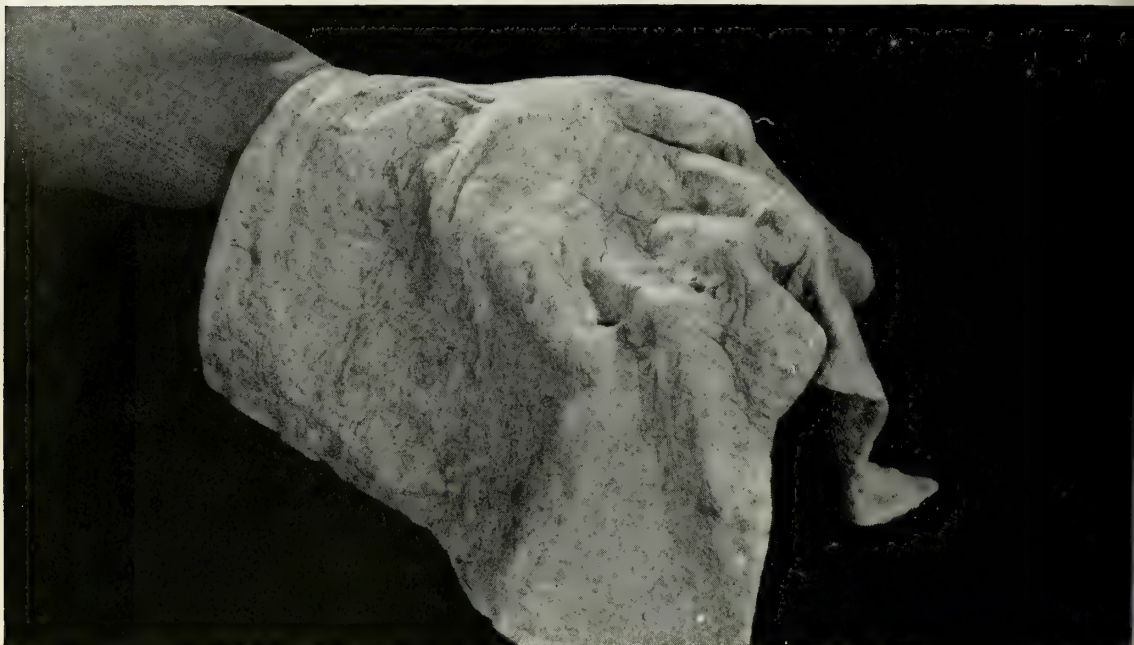
CLOSE-UP drawing of X-15/Blue Scout launching and jettison mechanism.



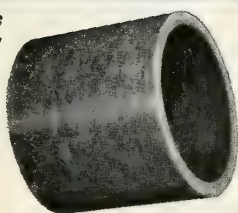
LAUNCH SEQUENCE of typical mission starts with B-52 take-off from Cape Canaveral.

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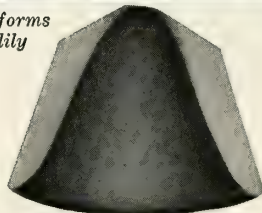
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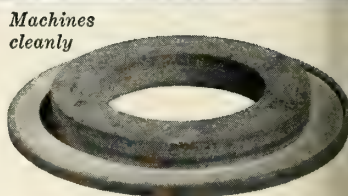
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# Technical Countdown

## ELECTRONICS

### Big Picture in Infrared

Data flashed to earth from orbiting infrared sensors will be viewed instantly by military commanders in normal light with multi-colors on a large screen. A situation Display console under development at General Electric's Heavy Military Electronics Dept. for use with *Midas* will provide an intensity comparable to the best home TV picture. The heart of the display is a unique Military Electronic Light valve projection system (MELVA). Push-button controls will permit viewing of individual sectors.

### Super-Pure Electronic Ceramics Produced

ITT is setting up a pilot production facility to demonstrate a new technique in the mass production of ultra-pure electronic ceramic materials. The process is capable of turning out large quantities of titanates, zirconates, niobates and other ceramics. The method is an outgrowth of an Air Force ASD research program.

### Verbal Backtalk from Computers

A device designated Unicall, which enables a computer to verbally reply to inquiries from hundreds of remote points, was unveiled by UNIVAC at the dedication of the firm's new \$20-million computer engineering center in Whitpain Township, Pa. The backtalk development is a simple alphanumeric input/output device designed to handle the remote input/output problems of missile/space firms.

### Bio-Power Trio Developed

Models of three basic bio-power devices have been built by Magna Products, Inc. One utilizes natural minerals and organic matter in sea water. A second involves organic matter and air. The third is a bio-solar cell which capitalizes on photosynthetic organisms that convert solar energy directly into electricity. The last has efficiency level possibilities far above any other known device. The units are already generating sufficient power to operate radio beacons, signal lights or other apparatus at sea.

## SUPPORT EQUIPMENT

### Fifth Wheel Navigator Held Feasible

Experiments conducted by Chrysler Corp. and Kearfott Div. of General Precision, Inc. have reportedly established the feasibility of a fifth wheel, odometer-type ground navigation system for mobile missiles. The tests—using a Chrysler fifth wheel odometer to measure the distance traveled and a hard-mounted Kearfott S-121 inertial navigator for a positive azimuth reference system—were run at speeds of up to 50 mph over a course simulating varied terrain conditions with good results, say project engineers.

### 'Hot Nose' To Sniff Air for Saturn

A spherical air data sensor—nicknamed "hot nose" or

"Q-ball"—will be used to measure angles of attack on the *Saturn*. Developed by Northrop for use on NASA's *X-15*, the sensor will be modified to eliminate the spherical ball and the hydraulic and servo equipment used on the rocket plane. Instead sensing ports will extend from the electronic equipment to external points on the *Saturn*'s nose cone.

## ASTRONAUTICS

### Variable Space Structures Proposed

A variable-geometry concept—used to build all-purpose frameworks for space structures—has been proposed by the Norair Div. of Northrop. These single enclosed skeletal structures could be fired into space in compact packages and unfolded into a variety of geometrical shapes. Norair engineers say these frameworks could be used to form satellites, antennas and re-entry vehicles in space.

## ADVANCED MATERIALS

### Glass Fibers as Nuclear Fuels?

Plutonium-bearing glass, in the form of minute fibers, may serve as reactor fuel. The large surface areas of the fibers readily lend themselves to use in either chemo-nuclear reactors or power reactors for electricity. The work is being done at Monsanto's Mound Labs, operated by the firm for the AEC.

### Non-Metallic Tooling Study Completed

Lockheed-Georgia has completed a development study in materials and tooling techniques for cast refractory or ceramic draw dies. Other research was devoted to the development of stretchform and hydroform blocks, heat-treat, stress relief and braze fixtures. The 487-page final report to the Air Force contains a considerable amount of brand-new basic information on castable refractories.

### Westinghouse in Pilot Nb-alloy Production

Three members of a family of columbium alloys are in pilot production at Westinghouse Materials Mfg. Dept. First to be produced will be a Nb-V alloy called B-33. The new alloys can operate in the 1800-3000°F range and are easily fabricated. They can be forged, rolled, sheared and handled directly, often at room temperatures, Westinghouse says.

## LIFE SUPPORT

### 'Biosonics' To Help Feed Astronauts?

The proper application of sound energy to plant growth may help feed astronauts in space, according to experiments conducted recently by Acoustica Associates, Inc. The tests showed that sound energy can stimulate the growth of cells and thereby accelerate plant growth. Acoustica engineers hope to apply this phenomenon to the problem of food supply in space vehicles.

# Mauler Means Fast And Tougher Air Defense

*Army forward area weapon, nearing system tests, will be entirely self-contained under control of operator*

by James Trainor

THE ARMY'S MAULER—a compact, rugged, highly mobile air defense system—is being developed to provide battlefield protection for forward battle area units.

Consisting of the missile, weapon pod and carrier vehicle, it will be a completely self-contained weapon possessing its own acquisition and tracking radars, computers, launcher, communications system and associated equipment.

*Mauler* will be able to detect, evaluate and engage battlefield free rockets of the *Honest John-Little John* class, guided missiles, and both fixed- and rotary-winged aircraft. It will rapidly assess the situation in a forward area and automatically engage targets with minimum participation by the operator. The system's design makes it possible to deploy the fire unit in Phase I and II airborne, amphibious or cross-country operations without degrading its immediate and continuous fire support capability.

The missile—radar-guided, high-performance and solid-fueled—is pre-packaged in a lightweight case which two men can easily carry and which serves as both a shipping container and a launch tube. The multiple load of *Maulers* is mounted on the launcher in rows.

Convair Div. of General Dynamics is prime contractor for the *Mauler* system. Other principal contractors are Raytheon Co.—radar system, Burroughs Corp.—computers, and FMC Corp.—vehicle.

The carrier vehicle—developed by

FMC under cognizance of Army Ordnance—is a lightweight, amphibious member of the M-113 family. It utilizes to the maximum the components from the M-113, giving the weapon system a high degree of mobility.

To insure a balanced weapon system design, each element—from target sensing to target engagement and inter-unit fire coordination—has been designed to complement the others. Hence each element reliably provides the performance needed for effective target kill and no more. Another advantage is that the operator at his fire control console has complete knowledge of what the system is doing and complete control over it at all times.

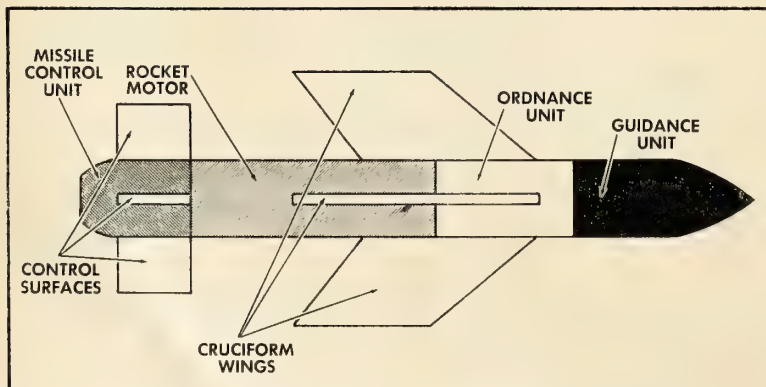
• **Operation** — *Mauler* effectively uses both analog and digital computers. One of these—the launch order computer—serves as the link between target designation and the track radar and the launcher.

When a designated target has been acquired by the track radar, the launch order computer becomes the pre-launch computing link between the tracking radar and the launcher. It also furnishes the pre-firing inputs to the missiles and provides synchronization interlocks and firing circuit interlocks. The computer accepts target data either from the track evaluation computer or from the operator.

All operations of *Mauler* are controlled from the operator's compartment, which contains the fire control console with its various controls and displays.

• **Canister and missile round**—The missile round—consisting of the canister and the missile—has been designed and packaged so that it can be carried and loaded by two men. The canister—constructed of light sheet metal and plastics—is composed of three major parts: the canister case, the cover and the desiccant holder. Between the double walls of the aluminum case, a semi-rigid polyurethane foam provides structural strength. Additional foam liner, varying amounts, is used within the case to support the missile. This allows a large lateral deflection at the forward end of the missile and a smaller deflection at the tail of the missile. In this manner, the most delicate components in the guidance section are protected from shock damage.

The cover of the canister is held



ARTIST'S CONCEPT of the *Mauler* missile shows the principal components of the weapon, each designed to complement the others for maximum reliability.





**GHLY MOBILE**, the Army's Mauler is a completely self-contained air defense system.

by two explosive bolts, electrically fired just prior to launch of the missile. The rear closure of the canister is sealed by a molded plastic containing a missile-to-canister electrical connector blown out just prior to launch to prevent the package is subjected to shock vibration. A thin diaphragm in the aft closure allows the escape of the exhaust gases. In addition, each missile container has a moisture-absorbing desiccant, a pressure relief valve and a visual humidity indicator.

The missile configuration and structure represents no advance in the state-of-the-art. It was developed as a trade-off between equipment internal volume requirements and the aerodynamic demands necessary for the required maneuverability and stability.

The *Mauler* has four trapezoidal wings in cruciform arrangement, with a set of four rectangular control surfaces located behind, and in line with, the wings to provide control for roll stabilization and maneuvering. To permit ease of handling, assembly and maintenance, the missile has been sectionalized and packaged into four main assemblies:

—A Guidance Unit, consisting of the control electronics and instruments.

—Missile Control Unit, comprised of the tail support, tails, hot-gas actuator, gas generators and two thermal batteries to furnish missile electrical power.

—Ordnance Unit, carrying the fuze, safing-and-arming mechanism and the warhead.

—The Rocket Motor, containing a case-bounded plastisol propellant with a slotted tube configuration, capable of performing over a wide range of environmental temperatures. The motor case is deep drawn and the aft closure and the wings—two steel-formed angles spot-welded together—are also welded on the motor case.

• **Weapon pod**—Although the pod design was restricted by the space and weight available on the track vehicle, the weapon pod contains all the necessary components for the *Mauler* fire unit: the pod structural housing, the turntable, the launcher supports and launcher, antenna mast and the gas turbine and air conditioning systems.

The pod is divided into three major components: the operator's compartment with the control console, track evaluation computer, position computer, communications equipment and space for two men; the gas turbine and air conditioning systems compartment with

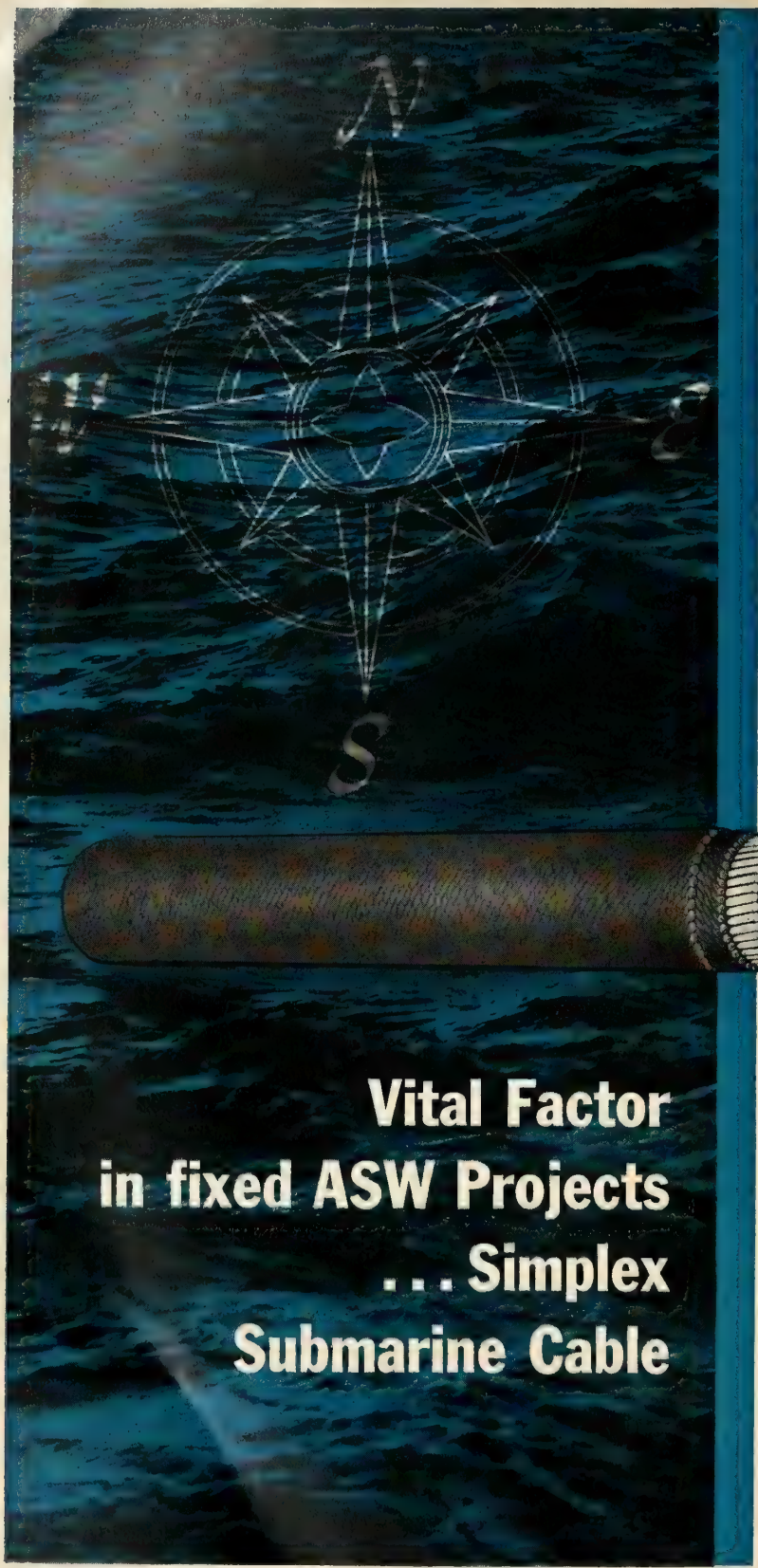
a fuel tank for the generator set located below; and the basket assembly compartment.

Access to the operator's compartment—the normal entrance in the mounted configuration—is through an overhead hatch. However, a door is provided at the forward end of the operator's compartment for use when the pod is dismounted. Also, when the pod is mounted a panel is removed from this door to provide a communications passageway between the pod and the vehicle and to furnish personnel an escape route through the vehicle in case of an emergency.

The hydraulic power supply for the on-turret hydraulic servo-valve systems consists of a motor and pump which provide power for the launcher evaluation mechanism, acquisition antenna stabilization and rotation, raising and lowering of the mast. It was necessary to remove the azimuth hydraulic drive system from the turret to minimize the power transmission losses.

The acquisition antenna mast is located at the rear of the turntable and may be placed in a minimum of three fixed positions: fully erected for system operation, fully lowered for air transport and low overhead clearances, and a 15-degree intermediate position





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driver visibility when the system is in a march-order, non-operating condition. In this position the mast will be supported by a removable yoke assembly. The mast will be raised and lowered by a hydraulic self-locking ram. Although the pod is stabilized in the mounted version—much the same as the gun platform on a tank—to provide a moving fire capability, means of stabilizing the pod assembly when it is dismounted are still under study. A preliminary concept to achieve this consisted of attaching four floats to the pod by using adjustable legs.

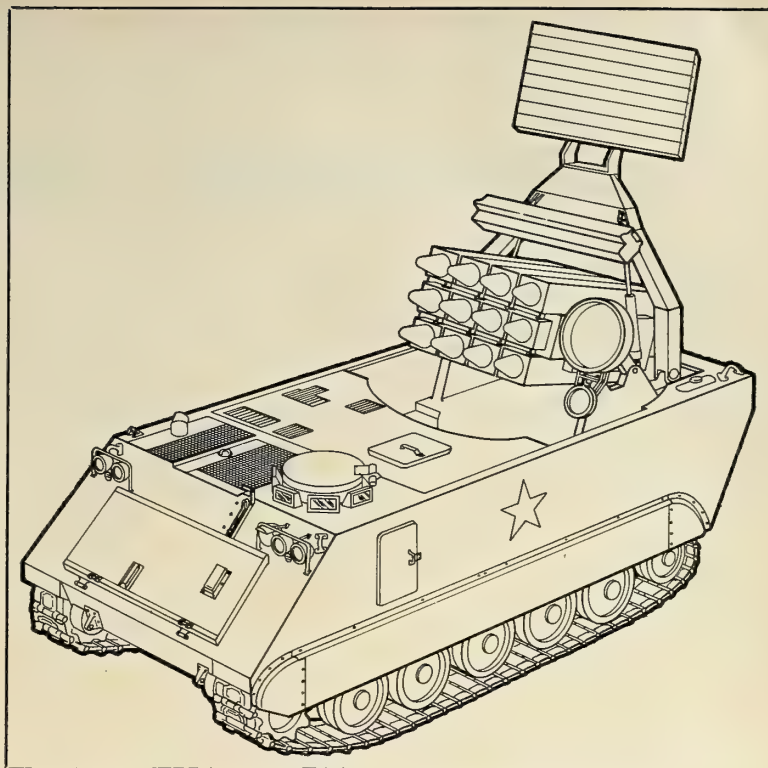
• **Mauler carrier vehicle**—A full-track, minimum armor unit, the *Mauler* (XM546) is powered by a 215-hp Chrysler V-8 engine and contains a transfer case, transmission and controlled differential, final drives, tracks and suspension system common to all M113 type vehicles. The vehicle—227 in. long, 100 in. wide and 75½ in. high at the top point—has an 111 in. wheelbase, identical to the XM472E2 vehicle used with the *Pershing*.

The combat weight of the vehicle with crew and weapon pod is approximately 25,000 lbs. In addition to both amphibious and cross-country capability, the vehicle also can maneuver in mud and snow and has a maximum speed of 40 mph over primary roads. The layout of the driver's compartment is similar to the M-113 in the location of controls, accessories and the escape hatch. However, the *Mauler* includes an escape hatch at the rear of the compartment to provide an emergency exit should the vehicle overturn or the overhead exit be blocked. Entrance to the vehicle cargo compartment and the pod basket assembly is by means of a ramp in the rear of the vehicle.

• **Complementary systems**—The auxiliary power unit consists of the turbine, a two-power take-off gearbox, a 3-phase alternator and the normal accessories. The voltage system is a 120-208-volt, 3-phase, 4-wire, 400-cycle system with d-c voltages for the control system and power provided by a transformer rectifier. To start the turbine and provide for low-current d-c requirements such as compartment lighting and radio communications, a 24-volt nickel-cadmium battery is used.

The *Mauler* turbine will burn JP-3, JP-4 or combat gasoline without any harmful effects. If combat gasoline is used, the operational time of the turbine may be extended by drawing on the vehicle fuel tank through the vehicle transfer system.

Air conditioning is provided for the crew, heating and ventilation of personnel and equipment in the pod and vehicle operator's compartments. De-



DRAWING SHOWS complete system, including multiple launch tubes and radars.

sign parameters require the system to cool the inside of the compartment to 90°F at 125°F outside temperature and heat the operator's compartment using two 5000 BTU strip heaters to 50°F at a -65°F outside temperature.

In conjunction with the air-conditioning system, consideration has been given to the study and development of a CBR collective protector. In fact, technical requirements for such a system—developed by the Army Chemical Corps—have been included in the air-conditioning specifications. Also included is a requirement for internal pressure sufficient to prevent leakage into the compartment due to normal overpressures caused by wind and vehicle movement.

• **Packaging the system**—Since the *Mauler* is completely within the state of the art, the main concern in system development has been in packaging the complete system into one highly mobile fire unit. Therefore, maximum use is being made of advanced packaging techniques including multi-side circuit boards, stripline and 3-D encapsulated components using micro-elements. All packaging is being designed so that fault isolation to the replaceable assembly requires the simplest of logic.

The basket-type assembly—or inverted "lazy susan" technique—was selected primarily because it was the most

direct method of eliminating a combination slipping, rotating joint waveguide, and hydraulic power transmission problem. The mounting of the radar assemblies in the rotating basket and use of separate hydraulic systems for on and off turret functions eliminated another major problem area.

The *Mauler* air defense system has been under development for approximately 18 months and is fast approaching system tests at White Sands Missile Range. The Army Rocket and Guided Missile Agency has overall responsibility for the development program. ❧

## U.S., Foreign Chemists Attend Varian Workshop

MORE THAN 200 scientists from throughout the free world will gather this week in Palo Alto, Calif., at Varian Associates for the company's fifth annual workshop on nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR).

Varian holds the yearly workshop to acquaint scientists with the latest advances in these fields.

Relatively new tools for chemical analysis, NMR and EPR spectroscopy allow chemists to probe the interior of intricate modules without either destroying the sample or interfering with biological processes. ❧

# Reproducible Glass Fibers Assured b

**Physiological methods are applied to fiber process; company's output aimed at solid and liquid cases**

by John F. Judge

THE FIRST glass fiber plant specifically designed to supply missile/space firms with constant-quality raw material for filament-wound rocket cases is in operation at Springfield, Va.

MPI Glass Fibers, Inc., expects to turn out 25,000 lbs. of glass fiber prepreg per month and intends to double this capacity by the end of the year.

MPI's Hi-Mod material (M/R, Dec. 12, 1960, p. 23) is being produced under conditions which eliminate all the variables inherent in the production of glass fibers and prepreps. The plant's entire output is aimed at the structural plastics industry.

The extreme emphasis on quality control is reflected in the program set

up by Dr. R. H. Peckham, president of Materials Testing Co., and consultant to MPI. The glass fiber firm gave Peckham the job of so disciplining the manufacturing process that complete and continuous uniformity is achieved in the end product.

Testing begins with the incoming raw materials. The unloading dock is separate from the production areas. Raw stock is individually bagged, since MPI believes bulk delivery adds to contamination problems.

MPI has developed a new method of batch mixing, resulting in a more homogenous furnace feed. No marbles are used; the initial components are powdered. Routine sampling procedures check the batches for moisture content and chemical composition.

• **Specialized melting**—Batches are fed into the furnace and fiber is drawn at a constant rate. The furnace itself was designed by Dr. C. Uhrmann, vice president of A. W. Schmid International—a firm with a worldwide reputation in fiber and sheet glass furnaces.

The furnace at MPI is in continuous

operation. There are three sets of controls in the refining section and two in each of the adjoining melting zone. There are no dead spots or corners to catch molten glass in the unit. The prime objective is to minimize the time from powder to fiber.

Fibers are generated by glass passing through a multi-holed platinum bushing. They are taken up by a large spinning and traversing drum. Resin is sprayed on the fiber "as soon as it is born." Nascent glass is extremely reactive and the thin fibers are almost a surface. Atmospheric contamination is a real danger. But immediate encapsulation by resin at the bushing protects each fiber from abrasion and preserves a major percentage of the material's inherent strength.

Another innovation is the size of the pick-up drums. The massive units traverse and rotate while picking up fiber. When full, they are easily rolled to one side for stripping while a clean drum enters from the other side.

J. F. Brossy, MPI vice president, says the large drums cut down fit-



GLASS FIBER testing techniques used at MPI were developed by Dr. A. Silverman (at left) in collaboration with Dr. R. Peckham (right).



LARGE WINDING drums continuously maintain perfect concentricity during

missiles and rockets, October 23, 1960



# ough Control Techniques at MPI

ss, permit longer sheets and provide  
ore uniformity because of the large  
c.

Temperature controls abound in  
e building. The furnace room is main-  
ained between 75 and 80°F and de-  
umidified. The resin preparation room,  
ass fiber storage area and batch-  
ixing sections are all constantly  
checked for temperature and humidity.

The fibers themselves undergo both  
physical and chemical control tests in  
the Peckham procedure. The diameters  
are checked microscopically with a  
modified apparatus which minimizes  
shadow width and eliminates image er-  
ror. An Instron is used for pulling and  
tensile checks.

Mat samples of fibers stored under  
controlled conditions are completely  
elasticized as they would be in actual  
application by a fabricator. The mat is  
then tested on a Wiedman-Baldwin with  
pulling and flexing capabilities up to  
4,000 lbs.

• **Applied medicine**—Peckham's  
knowledge of physiology is being ap-  
plied to the chemical controls. In the

measurement of human body fluids, it  
is difficult to obtain a direct analysis  
immediately. The standard method is to  
"burn" dry tissue to ash in acid, which  
removes the proteins and carbohydrates  
and leaves the salts. The salts are dis-  
solved in water and introduced to a  
oxy-hydrogen flame.

The light from the flame is run  
through a spectroscope and the in-  
tensity of the characteristic lines de-  
termines the amount of material.

The flame method is used in physi-  
ology to determine the quantities of  
sodium and calcium in a tissue sample.  
These are the same elements that must  
be determined in a glass fiber sample,  
together with small amounts of lithium  
and aluminum.

In borrowing from the field of medi-  
cine, MPI substitutes the flame method  
for the more standard gravimetric anal-  
ysis—cutting procedure time from 30-  
60 hours down to 30-50 minutes. The  
fiber is digested in hydrofluoric and  
perchloric acid contained in platinum  
crucibles—the mixture will easily dis-  
solve laboratory glass. The sample is

heated and reduced to the condition of  
a salt. The residue is added to water  
and introduced to the flame.

The chemical control process will  
be run in a medical laboratory using a  
Beckman DU Spectrophotometer. A  
second independent and certified lab-  
oratory will check all of MPI's quality  
control measurements.

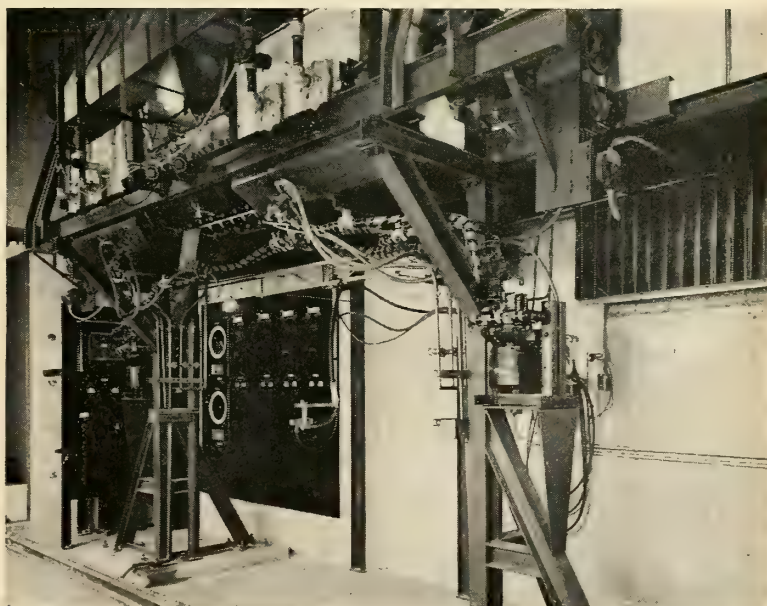
The continuous quality control pro-  
cedure will catch any impure batch the  
same day the tests are run. No sub-  
standard material will be shipped. Re-  
jectable products, if any, will be ab-  
sorbed by MPI—not by the fabricator.

The firm planned the facility with  
easy expansion in mind. There is ample  
room for more furnaces in a large area  
adjacent to the present unit. The build-  
ing's interior is maintained at near-hos-  
pital standards in respect to cleanliness.

The extreme emphasis on quality  
control and reproducibility is a direct  
result of the demands by the many  
missile/space firms currently engaged  
in perfecting filament winding tech-  
niques for a host of space applica-  
tions. ::



Production of parallel glass fibers. J. F.  
Blissy developed the entire process.



SPECIALLY DESIGNED furnace undergoing shakedown at MPI is honeycombed with  
temperature and other controls. Unit shortens time between batch and formed fiber.

# Refractory Coating by Fluidized Bed

**Boeing advances technology with process that cuts costs, time and chances of warpage; no apparent limits on size**

PROTECTIVE COATINGS are being applied to refractory metals through a novel fluidized bed process perfected by The Boeing Co.'s Aerospace Division.

The process is faster and cheaper than the widely used pack cementation method.

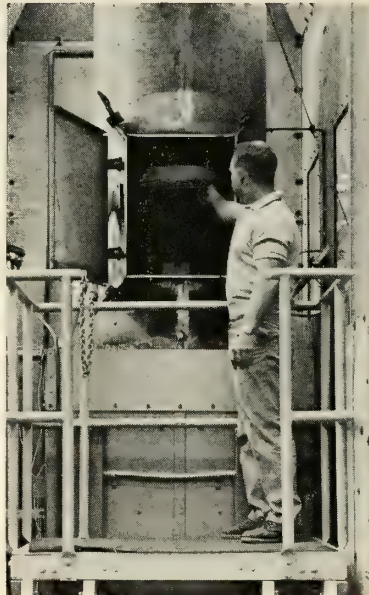
The fluidized bed concept is not new—Boeing first developed it as a uniform heat source. But its application to refractory metal coating represents a significant advance in coating technology.

The operating section of the process consists of a reactor filled with powdered silicon. In the unactivated condition, the material is packed. But as heated argon and iodine gases are pushed up through the bed, the powder becomes fluidized and turbulent. Any object with a density greater than that of the fluidized powder can be easily immersed.

The iodine reacts with silicon to form silicon tetraiodide, which in turn reacts with an immersed refractory part such as molybdenum, generating the protective coating.

The dynamic action of the fluidized particles keeps the temperatures constant throughout the bed; the part, or assembly shape, is completely covered without resorting to a special retort.

The loading and unloading of a part takes a little over 20 minutes.



LOADING PORT of current experimental bed apparatus. Part to be coated is lowered into bed after port is shut.

Coating time varies from two to eight hours, depending on the desired thickness. Coated parts have been exposed to temperatures of 3000°F for hours without damage. Tests simulating re-entry conditions are under way.

• **Scales up easily**—Boeing expert see no inherent size limitation to the process, and the main hurdle is the cost of the argon gas. An inert gas must be used because of the nature of the reactants and the parts to be coated. Work is being performed on recovery and recycling systems for the argon.

The pack cementation process is the largest area now being investigated in the crucial field of refractory coatings. The process consists of embedding the metal to be coated in a mixture of powders containing the materials to be deposited, carrier compounds, atmosphere controlling compounds and inert filler material.

The entire pack is then charged in a sealed retort and heated up to 2200°F for several hours. The process depends on displacement reactions by metal halides.

The principle drawbacks of the process are:

—Long-term heating of substrate at high temperatures, which sometimes results in recrystallization.

—The difficulty of uniformly heating very large packs and maintaining the temperature for very long periods.

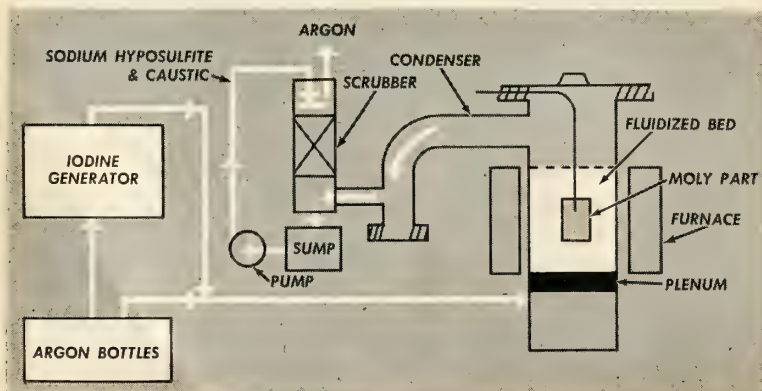
—Occasional problems in removing sintered powders from outside and inside part surfaces.

Any advantages of the pack cementation method are carried over into the Boeing development. The fluidized bed method produces uniform and reproducible coatings due to the uniformity of temperature and chemical activity throughout the reactor.

Specialized tooling and retorts are not necessary. Process time is much shorter than pack cementation, and number of parts can be handled simultaneously.

Another, subtle, benefit is the reduction of warpage possibilities. The inherent close control cuts down the introduction of unknown variables. Most of the current work at Boeing has been with molybdenum, but the process will coat any refractory capable of a displacement reaction.

The process will be licensed by Boeing Applied Products.

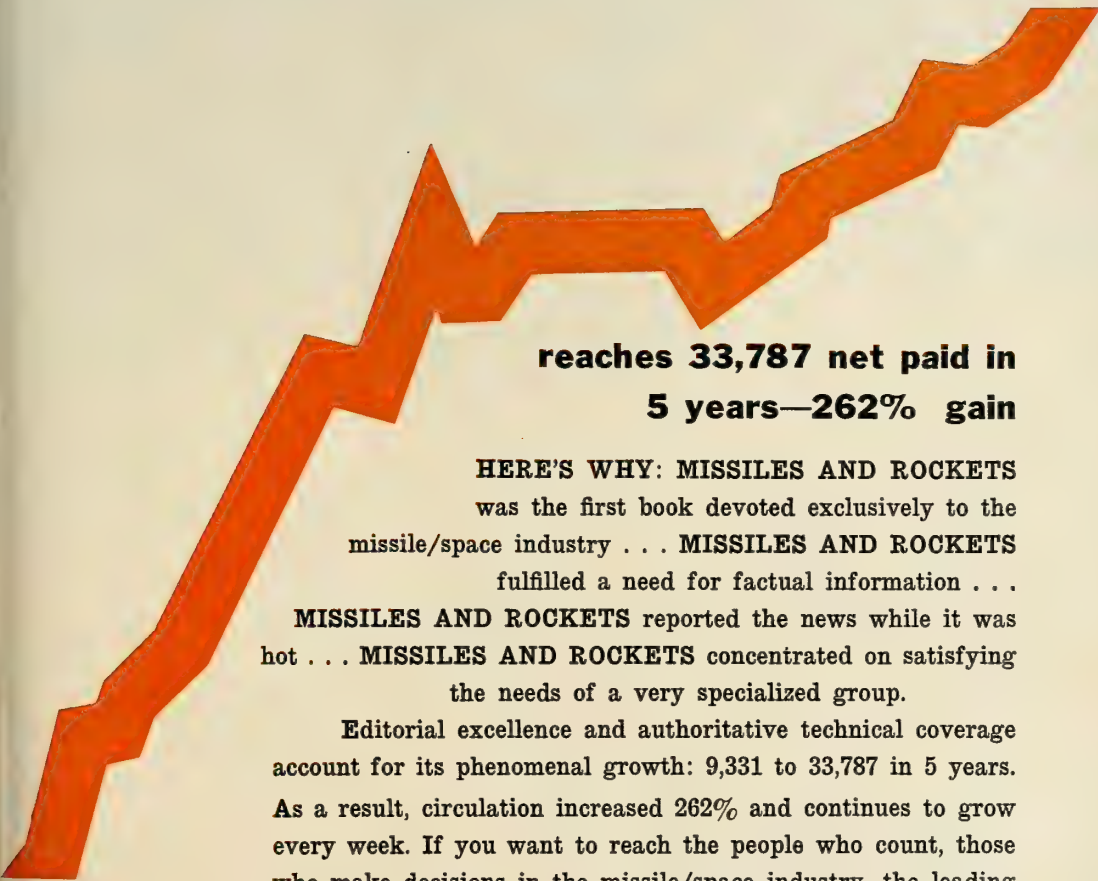


The Fluidized Bed Process



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## missiles and rockets

The missile/space weekly • An American Aviation Publication  
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# U.S.-Industry Relations—A New Look

IT SEEMS TO ME we have reached a point where reappraisal of government-industry relationships is timely, particularly with reference to those of us who serve the nation as defense contractors. It may in some respects be an agonizing reappraisal, complicated by sensitive social, economic and political questions. But the stakes are high. At issue is the continued good health of our vast industrial machine, which for two generations has been the basis of national power, and which today is the bulwark of the free world.

The remark is frequently made that man's social progress has not kept pace with his scientific and technological advances. I suggest that the same thought applies to the government-industry relationships we are discussing. Government requirements are more challenging than ever before. The technologies with which we now deal, and the end items we now produce, are advanced beyond anything dreamed of just a few years ago.

But have our methods of doing business kept pace? I think not. I think we must ask ourselves not only whether the mechanics of government-industry business relationships are adequate, but whether the underlying philosophy of that relationship may not need updating.

• **Changing ground rules**—The business of producing defense items for the government has undergone radical change in the last 20 years. The seller-buyer relationship used to be a lot simpler. Of course, the government has always tried to be a careful and demanding buyer, as it should be. But, compared to the present, its day-to-day participation in the contractor's business was once rather mild—and, let's be honest, the policies of firms doing business with the government were designed to keep it that way.

Now, however, many of us are selling a different kind of product, and the ground rules have changed. Often our product is no longer a single item, like an airplane; it is an entire weapon system. We get paid not only for hardware, but for managing a vast program involving huge sums, of which only a small portion actually goes for something we ourselves manufacture.

• **Two-way challenge**—There can



Donald W. Douglas Jr.

*DUE TO the timely nature of the subject and the important position held in the missile/space industry by Mr. Douglas, MISSILES AND ROCKETS is presenting, somewhat condensed, the text of his speech to the Western Briefing Conference on Government Contracts at Monterey, Calif., on Oct. 6.*

*After extensive experience in lower echelons of the company, Mr. Douglas was named president of Douglas Aircraft in October, 1957. He joined the firm in 1939 after completing engineering studies at Stanford University and Curtiss-Wright Technical Institute. He became a vice president in 1951 and was elected a director of the company in 1953.*

be no question about requiring industry, in working for government, to follow basic precepts laid down by our elected representatives in Washington. But we are entitled to explore realistically the best means to achieve this.

I think there is a challenge here for both government and industry. Business must learn to be more responsive to the forward movement of this country's social and economic philosophy, as reflected by government. And then government for its part, must recognize such responsiveness when it occurs, and reward it with greater responsibility and trust.

When a system manager comes to

the point where the books of an associate or subcontractor must be audited he runs smack into the problem of proprietary and confidential information. We have detoured around this question by calling in the government, but, as a result, we often find ourselves without knowledge and authority commensurate with the responsibility we have assumed.

• **New legislation needed**—Or take the even more fundamental question of competitive versus negotiated procurement. Is the basic procurement legislation of 1947 really adequate to our present and prospective needs?

The complexity of the hardware and systems being produced increases by leaps and bounds. Tremendous research and development effort is required.

As a result, the number of prospective contractors capable of bidding, and qualified to bid, is sometimes very limited. In these circumstances, the statutory requirement for advertised bids is both unrealistic and antiquated, and does not serve the best interests of the government itself. The near impossibility of accurately predicting costs or the final form the weapon system will take makes negotiation with qualified companies the only practical path to follow.

The statistics on negotiated versus competitive contracts reflect what has happened: how government has necessarily gone in heavily for negotiated contracts.

But this has been accomplished through a series of exceptions, not through recognition in basic procurement legislation of the new facts of life. I think a fresh look at this legislation, in the light of what we know today, would be a very healthy thing.

• **Clouded image**—Before we can approach specific problems, however, it seems to me we must, as a nation, develop our fundamental philosophy with respect to defense industry. We must make up our minds whether we wish to regard it as a dangerous conspiracy, which, with the military, is a force for evil—or whether, on the other hand, the defense industry should be treated as an essential and respected civilian partner of our men in uniform.

While there is always room for it in missiles and rockets, October 23, 1960



ovement, I think our defense industries are trying to do a responsible job. Our task is to advance these efforts—not to throw brickbats. And one of the most important things we can do is clarify for defense industry just what our philosophy is concerning its place in our national life.

We must make up our minds whether we regard defense industry as a fully private enterprise, quasi-public, or what?

We must make up our minds whether we are against Big Business as a fundamental policy, or whether we recognize that the demands of some technologies are such that only tremendous organizations can rise to the challenge.

• **Bigness prerequisite**—Take my industry, for example. The advent of missiles and space systems has not only revolutionized its nature, but increased competition by providing an opportunity for the participation of many new companies, some of them well-established giants of other industries. At this white the cost of remaining competitive—technologically, administratively, and in facilities—grows by leaps and bounds that bigness is usually a prerequisite to success.

Throughout defense industry, and particularly in the aerospace area, the product mix has made surplus—at least very uneconomic—a substantial portion of the vast facilities built to meet the needs of the second world war. The government quite properly is not interested in paying excessive maintenance costs to support inefficient utilization. But will it permit, let alone foster, mergers designed to improve the situation? I don't think there is yet a clear answer. The proposed swallowing of a major electronics producer by a colossus of Detroit has produced hardly a ripple of protest. Yet a recent merger in the aerospace industry on much smaller proportions is under fire by the Department of Justice.

• **Effort under way**—I have raised a number of questions, but I have offered no answers. I have no easy answers. I don't think there are any pat solutions.

But I do think we must all face up to our problems, and give more time and effort to finding good solutions.

There are encouraging signs that we are beginning to do this. In the Pentagon, and in other federal agencies, efforts are being made. Government and industry leaders are discussing some of the questions I have raised.

We must proceed along these lines with all the good will at our command. We must stint no effort in securing solutions that are both practical and politically feasible, which is no mean task. ■

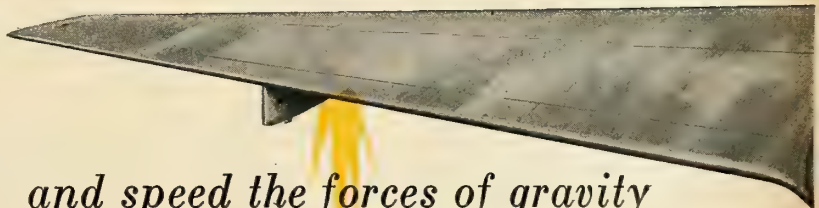
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## soviet affairs

By Dr. Albert Parry

### Rockets are being fired against thunderstorms

by Russian weather-makers, according to an article by I. Khutsishvili in *Komsomolskaya Pravda* of Oct. 4. He describes how a sizable group of Soviet geophysicists launched rockets at a menacing thundercloud and rendered it not only harmless, but beneficial.

The cloud, moving at a height of 10 kilometers, threatened to destroy a valuable crop of grapes with a shower of icy hail. Soviet scientists had ringed the fertile Alazan Valley in Kakhketia (Soviet Georgia in Transcaucasia) with 11 special rocket installations. The village of Rulspiri with its vineyards was the crucial area to be saved.

At a given signal, rockets from all 11 points were fired at the cloud. They were "charged with special chemical ingredients—with reagents which 'deceived' the cloud" into "an artificial crystallization of its hail" at a safe level, thus changing the damaging hail into a good rain. The author reveals that this work of cloud-transformation by rockets is being done under the auspices of the Georgian Academy of Sciences and the Hydro-Meteorological Service of the USSR. Two photographs accompany the article.

### Rare Space-Age elements get lost

in the current Soviet processing of metals. This is the complaint of Peter Antropov, the USSR's Minister of Geology and Ore Conservation, writing in *Izvestia* for Sept. 15. As metals are processed in Soviet plants, he reports, "rare elements contained therein are often wasted completely." He reminds his fellow countrymen that "many rare and scattered elements, such as indium, rubidium, gallium, hafnium, rhenium, germanium, selenium, cadmium and others, generally do not form deposits by themselves, but can be obtained from complex ores only."

Antropov pleads for "a more rational utilization" of such processed ores to secure the rare elements. How badly some important elements are being processed in the Soviet Union is illustrated by Antropov's declaration that "in obtaining mica we waste nearly 90 per cent of this valued mineral."

### Alloys with predetermined physical qualities

are a field where Soviet science and technology should do much bold experimentation. This is the message of the article "Marvelous Alloy Serves Man" by I. Golikov, a doctor of technical sciences, in the Sept. 22 *Izvestia*. Alloys with "an extraordinarily high magnetic permeability" he mentions as especially needed for Soviet computers.

"As we evolve new heat-resisting alloys," he writes, "rare elements will be used ever so more widely. Adding these will give the alloys a whole series of valuable qualities. For instance, a comparatively small admixture of boron will sharply enhance a metal's ability to absorb thermal neutrons."

### Experimentation with precise alloys

is being carried on in Russia at the Bardin Scientific Research Institute of Black Metallurgy (named in honor of the late Academician Ivan Bardin). An item on "Sensitive Alloys" in *Ogoniok* for Aug. 20 describes one of the Institute's products: a thermometer with neither mercury nor alcohol but with a spring made of two metals, each of the pair reacting to temperatures differently, but together smoothly regulating the flow of gas into a burner.

The item says the Institute experiments with alloys for the needs of "precise instrumentation, electronics, and the radio industry."

### U.S. Army use of electronic machinery

is summarized in a detailed article by Colonel P. Tkachenko, an engineer and a candidate of technical sciences, in *Krasnaya Zvezda* for Sept. 21.

missiles and rockets, October 23, 19



# 3M Materials Memo

News of materials for the aerospace industry — selected from the 27,000 products of the 3M Company



## A GOOD PIECE OF GOODS

3-4! Concentrated hydrochloric acid! Sodium Hydroxide! Ethyl alcohol! All killed on your Sunday suit? Obviously a chemist's nightmare. Of course, you could laugh in your sleep and wake with a smile, if that suit were tailored from one of the 3M Fabrics coated with "Fluorel" Elastomers.

3M's IRVINGTON DIVISION now offers "Dacron" fabrics coated with fluorine stabilized "Fluorel" Brand Elastomers. They'll coat other industrial textiles, too, under special arrangements.

Unlike most fabric coatings, "Fluorel" Elastomers do not greatly increase the stiffness of the base fabric. You don't have to walk stiff-legged in a pair of pants coated with "Fluorel" Elastomers even at low temperatures (no cracking after 2 hours at  $-100^{\circ}\text{F}$ ), and the abrasion resistance will satisfy the most discriminating gentleman. Even a hot seat (10 days at  $400^{\circ}\text{F}$ ) won't change the properties, nor will a year's weathering in industrial atmosphere. Low permeability and flame resistance are extra pluses.

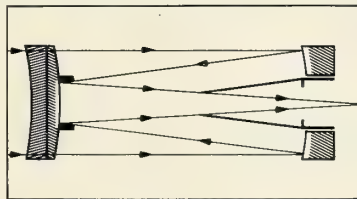
Yes, a fabric coated with "Fluorel" Elastomers is a "Good Piece of Goods" for protective clothing, ducting, hoses, flexible containers, blast deflection curtains and even gaskets and diaphragms. If you need resistance to heat, cold, fuel and corrosive chemicals, check the coupon for more specific information.

## SEVEN LEAGUE OPTICS

Though the fact is almost eclipsed by the staggering impact of the pizza pie, sunny Italy has in its day made another small contribution or two to this world's technology. Tucked away in the annals of history we find the account of a bright young lad of Pisa called Galileo. Telescope making was one of his specialties.

We think he did a first rate job under the circumstances — but telescopic optics have come a long way since then. There's been the Newtonian system; the Cassegrain; the Gregorian; the Schmidt — and finally the fully corrected catadioptric telephoto objective, a product made by the Wollensak Optical Company (now part of the 3M family), and sold under the trade-mark "Mirrotel".

It's quite a departure from the conventional refractor types. The biggest difference is the use of mirror optics which actually "fold" the light path three times. This means for one thing that it gives you that "long reach" at less than  $\frac{1}{3}$  the length and weight of equivalent refractor telephoto objectives. But that's just the beginning. With "Mirrotel" Brand Catadioptric Optical Lenses there's no chromatic aberration (no re-focusing for infrared), no coma, astigmatism, or distortion. No unwanted internal reflections, either, thanks to anti-reflection coatings on all glass-air surfaces.



All this at a cost that's far more reasonable than the older classical mirror optic systems.

Like to see how the "Mirrotel" Lenses can be applied to help you "reach" your goals in missile tracking or radar bore-sighting (or many other) operations? Get the whole picture by clipping the coupon.

## WELL ROUNDED DIET



Tired of cutting corners to bring reactor costs (and efficiencies) in line? We can help you lick the problem by eliminating the corners in your nuclear fuels. This is one place where the figurative and the literal overlap. Since no one has ever found a corner in a sphere, our Nuclear Products Group decided that this was the shape to aim for. The result — "3M" Brand Fueled Microspheres.

But why all this fuss over the sphere? Spherical particles offer advantages from both a structural and chemical point of view. Their higher strength and fracture resistance minimize fuel particle breakup during fabrication of dispersion fuel elements. The low surface area of the sphere decreases the degree of reaction between fuel particles and matrix materials. It facilitates handling by reducing the reactivity in contact with air. There's also reduced pyrophoricity and freer flowing characteristics.

The "3M" Brand Fueled Microspheres offer you all this and more. You can take your choice of  $\text{UC}_2$  or  $\text{ThC}_2/\text{UC}_2$  in any size range within 3–500 microns. They can be furnished if you'd like with overcoats of pyrocarbon. These are particularly useful in protecting  $\text{ThC}_2$  containing microspheres against oxidation from the atmosphere. They also make a dandy fission product barrier. Furthermore, you'll have less hot spot troubles by fuel particles touching each other. Why not consider a reactor design that's on the ball using "3M" Brand Fueled Microspheres? For more data, drop us a line.

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**Second report from ARS . . .**

## Electronics Requirements Intensify

***GD/A proposes two types of deep-space sun-orbiting satellites; AF scientist blasts 'pseudo-simulators'***

### ARS Coverage

**THIS REPORT** on electronics and space medicine is the second of two articles on the American Rocket Society meeting in New York. The first appeared in last week's issue. This report was compiled by associate editors Charles LaFond, David Newman and Heather David. **MISSILES AND ROCKETS** photographs by Guido Organschi.

**NEW YORK**—An increasing demand for improved electronic equipment and growing attention to weaknesses in space medicine were among the trends evident at the American Rocket Society's Space Flight Report to the Nation, which closed last week at the New York Coliseum.

Among electronic developments, a deep-space solar-orbiting satellite was proposed as a means for continuously monitoring solar flares. Through such a study, say scientists at General Dynamics/Astronautics, measurements could be obtained which might help reduce the deadly hazards of such eruptions and thus greatly increase the probability of safe manned space missions.

Results of Astronautics' Solar Monitor study were presented in a paper by the division's project director, Dr. J. H. Guill.

By using the big *Saturn* booster as first stage and a nuclear-powered upper stage, the proposed 2.5-ton Solar Monitor could be placed in a highly elliptical orbit about 12 weeks after launch.

To perform such a feat, the scientist

said, would require considerably more energy and velocity than are now available from chemical boosters. However, he said, nuclear power could do the job since it would provide an unlimited energy source.

Two vehicle configurations were suggested: one a top-shaped structure which would transmit measured data and photographs; another which would perform similar observations but would have its two 1950-sq.-ft. paddles, resembling a "single-wing Wright Brothers aircraft."

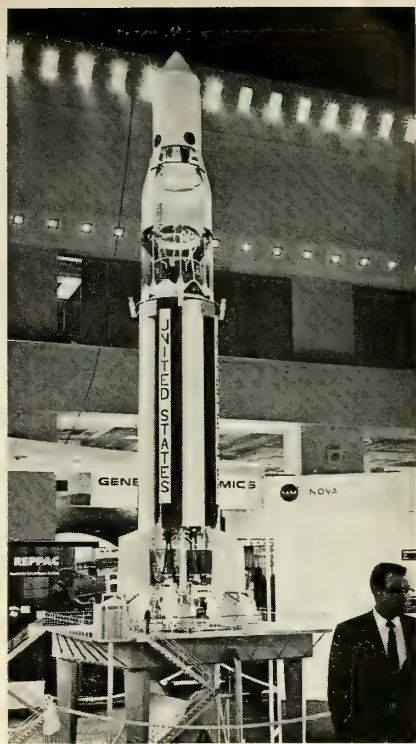
Under the GD/A concept, main booster separation would occur at about 20-25 miles above the earth. Trajectory time is expected to be from 60-90 days for the approximately 80 million-mile distance.

In orbit, perihelion will be from 5 million miles, aphelion from 40-90 million miles. A velocity range from a minimum of 47,000 mph to from 200,000-300,000 mph would be reasonable, the scientist said.

Solar-powered and with a 90-day orbital period, the satellite could be



**FT:** Panoramic view of second floor of three-floor American Rocket Society Exhibit in Coliseum. **RIGHT:** Model of Solar Monitor satellite employing solar turbo-electric power source, one of two sun-suit approaches presented by General Dynamics/Astronautics. **FAR RIGHT:** NASA's exhibit featured three-man Apollo spacecraft atop a Saturn model equipped with eight new stability fins. **BELOW:** Model of reflecting telescope designed and developed by Perkin-Elmer Co. for use in Postat Stratoscope II is shown in the exhibit's display.



## Space Medicine Flaws Attacked

ged to operate successfully for about year.

Two types of electrical power sources have been suggested, resulting in two completely different vehicle configurations. One is a solar turbo-generator which uses a 20-ft.-diameter solar collector dish to focus the sun's energy on a liquid metal boiler. The other would be a solar thermoelectric converter capable of collecting energy with two huge paddles. Heat energy would be converted directly into electrical energy.

Temperatures at perihelion probably would exceed 2000°F; however, Dr. Guille believes that with a suitable reflecting skin the satellite will remain cool enough to operate satisfactorily. The Solar Monitor, as now conceived, would be capable of measuring temperature, speed, energies, and dimensions of fast-charged particles emanating from the solar region during each solar flare. Data collected will be stored and transmitted periodically or on command to ground stations on earth.

**New concepts unnecessary**—No

new concepts are needed, said R. J. Keeler of Minneapolis-Honeywell Regulator Co., to satisfy present requirements for injection guidance or control in space.

For specific applications, many of today's different types of guidance designs may be used in composite systems, he stressed. Of the three major types existing now—attitude control, radio, and inertial guidance—inertial is the most promising. A closed-loop system not limited by line-of-sight operation, it has the necessary flexibility to handle the full scope of injection guidance requirements.

For long space missions, however, the trend is toward self-contained inertial systems with additional aids, such as optical trackers, to enhance long-term precision. To perform economically the same system should also be able to perform mid-course and terminal guidance requirements.

The addition of man, he asserted, does not change the situation. He will be used only to enhance the reliability of the automatic guidance system by

providing a redundant method of decision-making and manipulation.

Further, Keeler said, any new guidance system must have the capability of being tested by itself in the actual operating environment—before the human operator is introduced as a part of the system.

In essence, he said, man is not integrated with the system but serves only to contribute to the probability of his own survival.

Finally, he suggested that four areas of continuous improvement are needed in guidance systems: reliability, performance, miniaturization, and simplification of countdown procedures.

All are being studied today and improvements will be made, but the general configuration of guidance systems will not change appreciably.

• **Cryo-nuclear gyro**—A cryogenic-nuclear gyroscope concept was described by T. P. Lang of Sperry-Rand Corporation. Completely solid-state, it would use the "intrinsic angular momentum of atomic nuclei to define and maintain a spatial reference," Lang said. Such a

directional gyro, he asserted, would eliminate all the primary sources of error present in conventional gyros.

The limit has been reached for any significant improvement with today's inertial elements, the author stated, and only such "far out" approaches offer prospect for real advances in gyro accuracy.

In the cryo-nuclear gyro, he asserted, the desired gyroscopic action is possible only under certain conditions relating to the nuclear environment. These determine the choice and state of the material used.

To effectively replace existing inertial elements, the device must be capable of (1) establishing a spatial reference direction, (2) maintaining this reference direction, and (3) providing reference readout.

It has been found, according to Lang, that because of its intrinsic spin and magnetic moment, a nucleus defines a unique direction in space. It retains this direction as long as no interaction takes place between the nucleus and its environment. However, under normal conditions the nuclei within a piece of material are randomly oriented and do not define a unique direction.

When external field polarization is employed, a desired orientation can be achieved, he asserted. The degree of orientation is directly proportional to the applied field strength and inversely proportional to temperature.

Sufficient orientation is obtainable, Lang said, at temperatures below 20°K and with magnetic fields of the order of 30,000 gauss.

Directional reference is maintained for a considerable period of time, he said, since the return to randomness of nuclei is very slow.

To sense reference direction, Lang indicated, several methods exist for measuring spin-state population. Nu-

clear magnetic resonance r-f detection and optical techniques (optical pumping and absorption) are the most sensitive so far considered.

He said that the approach appears sound in theory, but much research remains before a working system is built and tested.

#### • Simplified telemetry needed —

Trends toward more complicated electronics in space vehicles—especially as manned craft are phased in—will seriously alter the reliability picture, said T. M. Conrad of Flight Electronics of Stafford, Pa.

While the weakest link today is in the booster, the major reliability problem tomorrow, he said, will be within the spacecraft itself, including the telemetering equipment. With this fact in mind, Conrad urged, we must start now to reduce complexity in telemetry system design.

Although his paper dealt specifically with systems applicable to biological payloads, the data were equally pertinent to telemetry systems in general—as well as to other electronics equipment.

The design of such systems, "simple in form, complex in function," demands a basic change in the current value systems of scientists and engineers, he said. Too often, the design is approached from the standpoint of human convenience, and the result is incredibly intricate configurations.

For example, Conrad noted that studies show the best telemetry system for manned vehicles to be a hybrid. Measurements best suited to automatic telemetering will employ that mode. But, for complex data transfer which requires intelligent processing, voice communications is best. Measurements bearing on the mission's success or crew's safety must be telemetered and displayed automatically for autonomous action by the crew and for rapid notification of ground stations.

## Medicine: some progress, many problems . . .

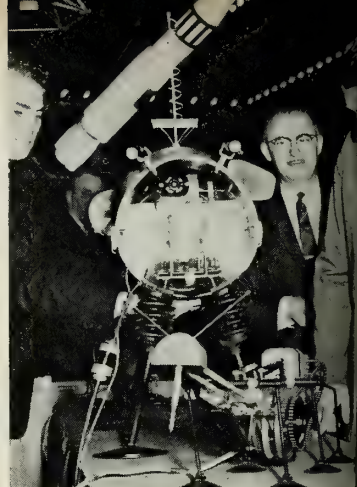
SIMULATORS that are suitable for no more than sales demonstrations are being used in spaceflight research, an Air Force expert charged.

Carl F. McNulty, chief of the simulation techniques section, Aerospace Medical Laboratory, told an ARS audience that serious shortcomings exist in spaceflight simulation because the designer is allowed to define the problem simulated after the simulator has been completed.

He deplored the use of generalized techniques and equipment, noting that simulation is not complete until it is

specialized. He named such equipment "pseudo-simulators."

The most important step, he stressed, is the acquisition and analysis of data on the system to be simulated. Basic principles he outlined are: a) an operation can be simulated only to the extent that it can be defined in a manner suitable for programing; b) simulation equipment has its own characteristics, which are imposed upon those of the operations simulated; c) a computer does not originate data, it transforms it from the form existing at the input into the form desired at the output.



NASA's Wernher von Braun looks over two "moon crawlers" in RCA's exhibit.



**ROCKETDYNE**  
A DIVISION OF NORTH AMERICAN AVIATION, INC.

ROCKETDYNE showed a model of engine in NERVA competition won by Aerojet.

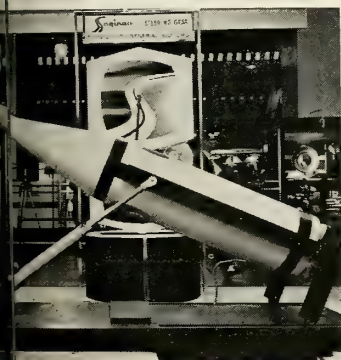


FIRST VIEW of Bendix Typhon missile seen alongside its earlier Talos (left).

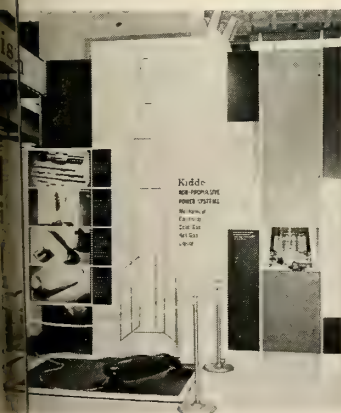




CALL BROS. displayed nose cone which used an NRL spectrograph Aug. 29.



SAINAW Div. of GM featured truck-mounted "Polaris" in its exhibit.



KIDDE & CO. showed controllable "Kidde Kai" concept for localized space travel.

Visual simulation techniques are especially lacking, he pointed out. Development programs for electronic data storage and closed-loop television will help overcome this defect.

• **Restraint systems**—Ling-Temco-Vought presented a new concept in restraint systems especially tailored for touchdown of a capsule parachute recovery system. The high g load it would allow—up to 60 g's forward, backward and sideways, 30 g's upward and 20 g's downward—would allow somewhat less sophistication in vehicle recovery equipment.

The concept, studied under an Air Force contract, is a hard-shell body which would restrain the internal organs from displacement. Major parts include a tubular skeleton seat frame, a molded fiberglass torso back shell, a molded seat pan, a molded fiberglass breast plate, a clamshell-type leg restraint and contoured armrests.

A remarkable feature of the suit is a soft leather helmet. The company pointed out that since the helmet was not needed for protection against windblast or collision, putting the additional inertial load of a rigid helmet on the spine was not justified. Primary job of the helmet is to position the straps which restrain the head from movement.

Added to the advantages of high g protection, the company claims the system can be entered in less than two minutes, unassisted. Impact testing is to begin shortly at Wright Field.

• **Advanced life support systems**—Dr. James N. Waggoner, Garrett Corp. official, said that an astronaut breathing 100% oxygen at 285 mm Hg. pressure may not function as well as he should on a long voyage.

Total duplication of sea-level conditions might not be necessary, but some careful changes could be made. For instance, it is believed that one-half sea-level pressure is sufficient as long as the partial pressure of oxygen is kept at 160 mm Hg. Nitrogen pressure can be supplied by a fluid mixture of oxygen and nitrogen, or by separate storage of the gases with suitable means of control of both total pressure and oxygen partial pressure.

• **Radiation problems stressed**—Two experts underscored the uncertainties and unknowns of space radiation and urged increased effort in this area.

Biophysicist Hermann J. Schaefer of the U.S. Naval School of Aviation Medicine said that astronauts will be expected to endure radiation loads far greater than the stringent standards established for laboratory and industry. In fact, they may be exposed to near lethal amounts. However, he pointed out that there is much uncertainty as to what part time plays in the danger.

A dose of 100 rem delivered instantaneously might produce acute symptoms, but the same dose spread over a period of several days probably would have no appreciable effect. He stressed the importance of possessing exact information on how the time element reduces the resulting net injury, and an accurate definition of the critical exposure levels.

Marshall Space Flight Center spokesman J. W. Keller warned that "over-shielding" will be necessary for manned space vehicles, until the solar proton phenomenon is understood enough to predict hazardous periods. He said that the U.S. needs research on: a) improvement of techniques for proton penetration calculations, including better handling of secondary productions and angular distribution of radiation for realistic shield geometries; b) determination of relative biological effectiveness for high-energy particles, and c) determination of differential cross sections for the production of secondary particles by high-energy nucleons.

• **Effects of CO<sub>2</sub>**—K. E. Schaefer of the U.S. Naval Research Laboratory at New London reported on an experiment in which 21 men were confined in a submarine with a CO<sub>2</sub> content of 1.5% for 42 days.

Results showed no significant change in blood pressure, pulse rate, weight or body temperature, but some remarkable adaptive changes occurred in respiration, acid base balance and calcium phosphorus metabolism. These changes occurred some three weeks after confinement, and had not disappeared completely more than four weeks after the experiment ended.

Schaefer concluded that since such far-reaching effects were present, some patho-physiological state might develop under this amount of CO<sub>2</sub>, even though its effects were not immediately obvious in basic physiological parameters.

• **Personal hygiene**—"Dirt" given off by both man and machine could result in serious impairment of performance, according to Spacelabs, Inc. engineers. A solution offered by the company is a "bath suit" which would restrict cleansing fluids near the skin, compensating for the problems of handling liquids in weightlessness. Reusable lint free spongecloths could be used for hand and face washing. Laundry would be done in bags much like the bath suit.

Dental care will be conventional, but the cleanser will be swallowed after use. Shaving will be accomplished with a lightweight electric shaver used next to an air inlet to catch hair clippings. Cabin cleaning of interior surfaces and instruments will be carried out by frequent sponging with thick spongecloths, using soap solutions. **\*\***

# 'Bottom Bounce' Tests Will be Fir

**Martin-chartered ship to use Navy's underwater range for basic research in submarine navigation and detection methods**

EXPERIMENTS in bouncing sound waves off the ocean floor—in an effort to gain information for navigating and detecting nuclear submarines—will mark the first use of the Navy's projected \$100-million ASW missile test range in the Bahamas.

The oceanographic research vessel Earl of Desmond will start this work. Chartered by The Martin Co. of Baltimore, the vessel set sail a week ago for Tongue of the Ocean and Exuma Sound—the Atlantic Underwater Test and Evaluation Center known as AUTEK.

The pressure on the Navy to increase its effectiveness in dealing with nuclear undersea craft is evidenced by its eager support of basic acoustic research. Less than a year has passed since Great Britain gave the United States permission to survey the area around the Bahama Islands in anticipation of AUTEK (M/R, Nov. 14, 1960, p. 13).

At the same time, the Navy Bureau

of Ships—responsible for constructing the range—let a \$500,000 study contract covering operation and development of AUTEK. Building was scheduled to start this year and to be completed in from five to 10 years.

The Earl of Desmond will open up the area to basic acoustic research in order to test the "bottom bounce" technique being pioneered by Martin.

• **So much talk**—The continuing and extreme difficulty in finding submerged submarines was brought out by James W. Fitzgerald, salty president of The Geraldines Ltd. of Annapolis, Md., owner of the Earl of Desmond and of three other vessels similarly outfitted for oceanographic research work. Fitzgerald, an old hand at sonar research, has developed, among other devices, Rhoc-Rubber—the sound-transparent rubber being used on moist sonar equipment.

Pointing out that we don't know anything about the sonar characteristics

of the ocean, he lamented that "we are further behind the Russians in oceanography than we are in space." He coined TENOC—the Navy's proposed ten-year plan for oceanographic research—as "ten years of talking about oceanography rather than doing anything about it."

He said that an analysis of all U.S. sonar contacts made during World War II shows that 91% of the time submarine was believed contacted but interpretation was wrong.

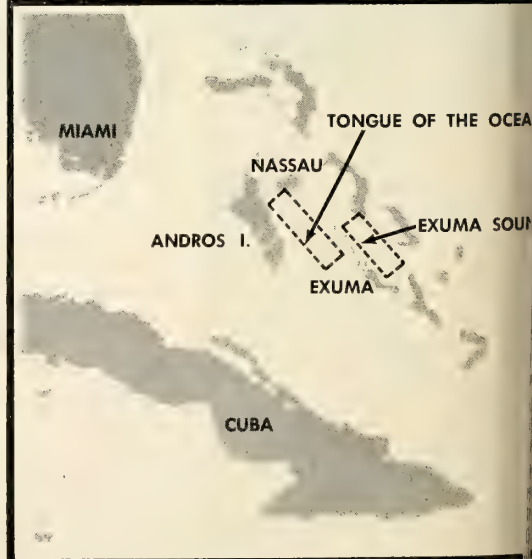
Today, the figure is little improved. Fitzgerald avers that based on current signals, sonar operators are still making false contacts 89% of the time.

• **Oceanographic task force**—Four vessels comprising the Geraldine fleet are said to be a balanced armament of floating scientific laboratories.

—All have facilities for maintaining scientific gear, preliminary data reduction and calibration of instruments.



EN ROUTE TO Navy's ASW missile range, research vessel Earl of Desmond will test "bottom bounce" theory of sound.



AUTEK, which includes Tongue of the Ocean and Exuma Sound, is ideal test range because of varying sea-floor terrain.

missiles and rockets, October 23, 1960



# AUTEC

William Beller

Two ships—the Earl of Desmond and the Earl of Kildare—have both sail and motor power. There are two advantages when sails are used: research testing can be conducted under way without interference from engine noise or vibration; and when a vessel moves to, the sails have a stabilizing effect resulting in a more-or-less level platform.

All vessels have wooden hulls to avoid the "echo" problems experienced by steel-hulled vessels engaging in acoustic and electronic research in the ocean.

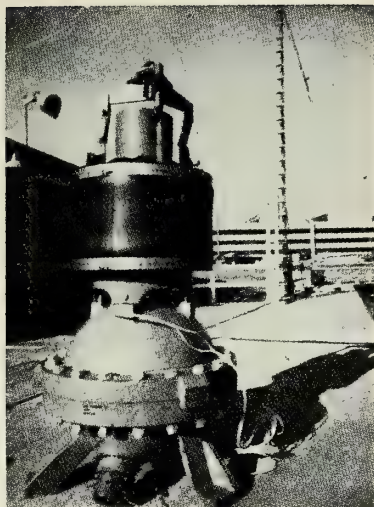
They all have primary power generators for operation and research in the waters in the world.

**Acquiring the data**—The Martin is called for the Earl to rendezvous at Little Creek, Va., with the Omega, a 50-ft. cable-laying ship owned by the U.S. Underseas Cable Co. At AUTEC, the two ships will operate as a team. The Omega will stay fixed while it reels out Martin's new low-frequency projector for testing.

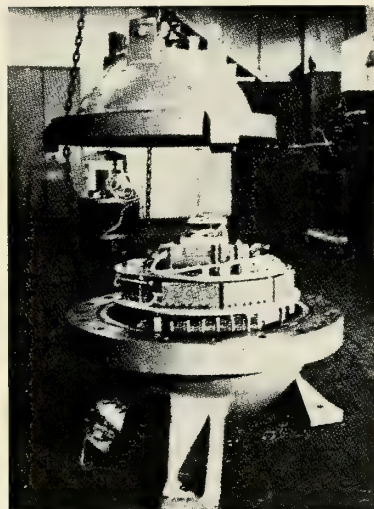
Meanwhile, the Earl will lower a Martin receiver at the end of a 1-in. cable. Every three miles, measurements will be made of acoustic pulse and temperature. These data will be taken along a vertical profile to establish an acoustic-ray pattern, check out projecting and sensing elements, learn the acoustic characteristics of Exuma Sound, and check out the theory of bottom bounce.

The Bahama Islands area was chosen for AUTEC because it is an excellent acoustic range having an underwater canyon with depths from 20 feet to one mile lies in a "cul-de-sac" which cuts down on ship traffic, usually has good weather year-round, is close to friendly countries (and sufficiently far from an unfriendly one, Cuba), and is easily and quickly accessible from the United States mainland.

**Trying the bottom bounce** — Main was recently awarded a six-month, \$99,000 Bureau of Ships study



*FISH 1—Martin's underwater projector plus sonar pressure sphere—is predecessor of unit to be tested in AUTEC.*



*SONAR PRESSURE sphere opened up shows electronic equipment for controlling projector and hydrophones.*

contract to design an advanced navigation aid for submerged submarines sailing in AUTEC waters.

John J. Slattery, general manager of the company's electronics division, said that both passive and active navigation aids will be considered. "The final system will include both submarine-borne and fixed underseas units."

"Findings to date," Slattery said, "suggest that the best navigation aid may use the 'bottom bounce' method of projecting underwater sound," in which sound is projected obliquely toward the ocean floor, bounces back to the surface and then falls back again to the ocean floor.

"This bounce effect may occur several times—depending on depth of the water, temperature, and the characteristics of the ocean floor," according to Slattery.

Direct acoustic propagation similar to radio broadcasting will also be investigated. Slattery added that nuclear fuel is one of several power sources being considered for the fixed underseas stations.

Martin's nuclear division has successfully devised small nuclear-power units such as the SNAP-1A and SNAP-3 isotopic power generators. These units use the heat generated by the decay of a radioisotope as the source of their energy.

Martin's first task, Slattery indicated, is to gather data in the AUTEC area about the behavior of sound after the bottom bounce. Design of the navigation aid and its power supply will follow. He said that emphasis will be placed on reliability because portions of the system will be installed in the ocean, which will make retrieval difficult.

• **In the beginning**—One of the outstanding results of Martin's ASW work is FISH 2, a deep-ocean active sonobuoy that for over a year traced acoustic ray patterns down to 15,000 feet of ocean (M/R, Jan. 23, p. 38). Robert Bonner, the company's director of ASW, says that this work "proves the feasibility of deep-ocean sonar."

FISH 1—a component of FISH 2—is simply an acoustic projector with supporting cable and electronics. It has been tested in deep waters so that its power requirements could be learned and its acoustic patterns traced.

An improved version of FISH 1 will be reeled out from the Omega during the impending series of AUTEC tests.

The "noise" output of FISH 1 comes from pulsing the projector's housing, which is made of staves of barium titanate. This ceramic is a piezoelectric substance, and therefore can be made to vibrate under a power input.

In early tests, FISH 1 performed so well that a hydrophone system—remotely steerable—was added to it and called "FISH 2." Tests showed that FISH 2 could use the angle and time interval of return of its acoustic signals to locate a body in water.

An added dividend is that FISH 2 can be effective over a large water area because of the wide spread of its ray pattern.

The first acoustic plumbing of the depths of the AUTEC range for basic sonar data will last for four weeks. Then the Earl and its companion, the Omega, will return to port for analysis of its FISH-derived data. ❧

## Midwest Reported Getting One-fourth of R&D Money

THE MIDWEST is getting some 25% of the nation's R&D money, amounting in fiscal '59-'60 to \$2.3 billion of a total \$9.2 billion.

Figures projected by *News Front* magazine set the 1960-61 figure at a total of \$10.5 billion, with the Midwest share at \$2.6 billion.

A survey conducted by Armour Research Foundation and presented at the National Electronics Conference at Chicago showed that the greatest share of Midwest research money was in chemicals, machinery and food. However, ARF said two industries pertinent to the NEC—electrical machine and instruments—had relatively minor roles in this area of the country. This was attributed to the location of electrical companies in the East, with labs usually located near management headquarters.

The survey showed that the Midwest has 25% of all R&D laboratories, and 30% of R&D personnel.

**THIOKOL CHEMICAL CORP.** has formed a life sciences research and development activity. The unit will be called Humetrics (the measurement of man), and will be under the direction of Dr. George L. Murphy. Offices and research lab facilities will be located at Culver City, Calif.

The activity will conduct integrated research, development and production of related hardware in a broad life sciences

area—including behavioral and engineering psychology, training, environmental psychology, and bio-electronics.

**RADIATION INC.** has established a subsidiary, Products Division of Radiation at Stanford (Calif.), to develop and market a standard off-the-shelf line of catalog electronic items.

**CORNING GLASS WORKS** is building a 120,000-sq.-ft. electronic components plant at Raleigh, N.C. It will produce fixed glass-dielectric capacitors, including capacitors for *Minuteman*. Manufacturing will be performed under temperature, dust and humidity control.

**THE MARTIN CO.** established the Martin Electronic Systems and Products Division to develop, design, manufacture and sell electronic systems and products for missile, space and undersea applications. Martin President William B. Bergen said "We expect the new division to become a major factor in the military and space electronics market in the next few years."

**AIR REDUCTION PACIFIC CO.** will begin construction of a new type of hydrogen production facility at its Richmond, Calif., plant. The unit, to cost some \$1 million, will produce ultra-high-purity gas.

**SIGNETICS CORP.** has been formed in Sunnyvale, Calif. to develop and manufacture complex miniaturized electronics circuits. Initial plans call for development of miniaturized electronic circuits to customers' specifications,

with the original products later forming the basis for a line of standardized items.

**GARRETT CORP's** AiResearch Manufacturing Co. of Los Angeles is building a laboratory for development of environmental control systems for manned extended space missions.

The facility will be used to research and develop environmental control components for fluid supply; fluid circulation; valves; atmospheric control; controls; and heat transfer units. It will include complete facilities for testing chemical elements of environmental systems under steady state conditions. The chamber will be able to simulate an extended multi-man space mission testing various types of environmental control systems.

**BENDIX CORP.** has designated two operating units the Bendix Aerospace Div. and the Bendix Automotive Div.

The company said the realignment separates military and commercial operations at South Bend and will permit more effective administration of both activities. The Aerospace Div. was formerly the aircraft section of Bendix.

**AEROTEST LABORATORIES** installed a new bipropellant testing facility. The addition to Aerotest's Space Environment Center tests subjects reliability, as well as internal and external compatibility with bipropellants such as nitrogen tetroxide, UDMH and hydrazine.

**GRUMMAN AIRCRAFT ENGINEERING CORP.** began operation of its new \$5-million Electronics Systems Center, Bethpage, N.Y.

Facilities include the largest radio frequency anechoic chamber in the world—110 ft. long, 40 ft. wide and 20 ft. high; precision radome bore-sight range for evaluation of stringent requirements on fire control system radomes; precision electronic standards Lab; flight condition simulation lab; and a systems evaluation area.

**MARQUARDT CORP.** established its Facilities Engineering operations as a corporate division. It will be responsible for facility and associated design projects for both governmental and commercial installations, such as environmental laboratories, launch system complexes, and facilities for hypersonic, hypersonic and nuclear propulsion testing.

The division, formerly operated as a function of the company's Power Systems Division, is under the direction of Malcolm F. McConnell.

## Financial Reports

| COMPANY                        | PERIOD         | INCOME       |              | EARNINGS  |            |
|--------------------------------|----------------|--------------|--------------|-----------|------------|
|                                |                | 1961         | 1960         | 1961      | 1960       |
| Acoustica Associates, Inc.     | 6 Mo. Aug. 31  | \$ 3,915,000 | \$ 4,187,314 | \$ 28,900 | \$ 121,655 |
| Adler Electronics, Inc.        | Year, July 31  | 8,963,000    | 3,643,000    | 234,000   | 56,000     |
| Aerojet General Corp.          | 9 Mo. Aug. 31  | 348,458,624  | 308,375,504  | 8,835,148 | 6,757,803  |
| Associated Testing Labs., Inc. | 3 Mo. Aug. 31  | 571,000      | 240,000      | 50,000    | 5,000      |
| Electro Instruments, Inc.      | 3 Mo. Aug. 31  | 2,564,513    | 1,862,677    | 94,958    | —125,323   |
| Garrett Corp.                  | Year, June 30  | 190,974,614  | 223,824,326  | 1,651,833 | 5,776,584  |
| Hallicrafters Co.              | Year, Aug. 31  | 55,141,000   | 29,374,000   | 1,660,000 | 907,000    |
| Int'l Rectifier Corp.          | Year, June 30  | 14,512,735   | 13,124,586   | 1,080,303 | 1,248,940  |
| Perkin-Elmer Corp.             | Year, July 31  | 25,500,000   | 22,100,000   | 1,319,521 | 1,208,805  |
| Polarad Electronics Corp.      | Year, June 30  | 12,812,702   | 15,438,985   | 50,098    | 745,469    |
| Raytheon Co.                   | 9 Mo. Sept. 30 | 407,142,000  | 402,830,000  | 4,847,000 | 6,139,000  |
| Sparion Corp.                  | Year, June 20  | 15,928,894   | 18,394,359   | —553,889  | 87,738     |





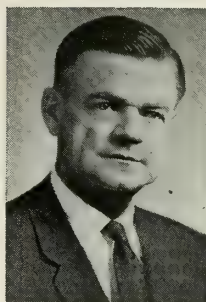
STOCKMAN



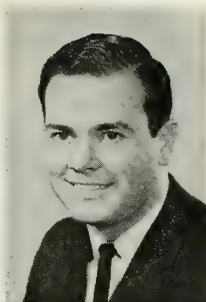
BARRY



WITTE



MANHART



FARR

The Vice President of the United States, **Lyndon B. Johnson**, is to be the recipient of the 1961 Silver Quill Award from the Specialized Business Press "for most distinguished service to business and industry."

The award will be presented at the Twelfth Annual State of the Nation Dinner, sponsored by National Business Publications and hosted by its member-p publishers, scheduled for Feb. 1, 1962, at the Sheraton-Park Hotel, Washington D.C.

**Frank L. Frain** and **J. R. Janssen**: Elected to vice president-treasurer and vice president-controller, respectively, at Lockheed Aircraft Corp., Burbank, Calif. **M. R. Janssen** appointed assistant treasurer.

**Dr. Donald A. Hicks**: Former Chief of Allied Physics Section, The Boeing Co., appointed vice president of Engineering, McDonnell Douglas Div., Northrop Corp., Van Nuys, Calif.

**Charles T. Roelke**: With United Aircraft Corp. over 20 years, appointed assistant general manager, Hamilton Standard Division, E. Hartford, Conn.

**Dr. Charles H. Stockman**: Named vice president and general manager, Goodrich High Voltage Astronautics, Inc., Burlington, Mass., a joint enterprise of B. F. Goodrich Co. and High Voltage Engineering Corp. Dr. Stockman formerly was manager, research operations, at Goodrich Research Center, Brecksville, Ohio.

**Dr. George N. Constan**: Appointed acting manager, NASA Marshall Space Flight Center's New Orleans operations. Formerly Dr. Constan was chief, Technical Program Coordination Office.

**Robert I. Barry, Jr.**: Named vice president of Defense Systems Services, Arcs Research & Development Corp., a subsidiary of Arcs Industries, Inc., New York City. Previously Barry was manager, Technical Documentation Dept., Page Communications Engineers.

**I. L. Doelz**: Vice president and general manager of Collins Radio Co.'s Information Science Center, Newport Beach,

Calif., named a director to fill the unexpired term of **R. S. Gates**, who resigned his board post in June.

**Dr. Edward E. Altschuler**: Named director of research and development, Gabriel Electronics, Millis, Mass. Previously Dr. Altschuler was with Electromagnetic Radiation Laboratory of the Air Force Cambridge Laboratories.

**James C. Hosken**: Formerly with Farrington Mfg. Co., appointed to new post of technical assistant to **E. D. Campbell**, general manager of LFE Electronics, a division of Laboratory for Electronics, Inc., Boston.

**Stuart Snyder**: Appointed manager, Operational Engineering Dept., Titan Program Office, Space Technology Laboratories, Inc., Los Angeles. **Leonard Schneider** appointed senior staff engineer in charge of reliability for STL's Minuteman Ballistic Missile Program Office. STL is a subsidiary of Thompson Ramo Wooldridge, Inc.

**R. R. Witte**: Appointed manager of Lockheed Aircraft Corp.'s Boston office, replacing **L. R. Hoffman**, who moves to Lockheed Electronics Co., Plainfield, N.J., as director of sales for the Military Systems Division. Witte formerly was executive assistant to **W. G. Myers**, vice president-marketing in Lockheed's corporate headquarters, Burbank, Calif.

**Charles D. Manhart**: Appointed vice president of Martin Co., Baltimore. He also will head the company's new Electronic Systems and Products Division, responsible for development, design, manu-

facture and sale of electronic systems and products for missile, space and undersea applications.

**Carl von Linsowe**: Appointed vice president and director of engineering, Ingersoll Kalamazoo Div., Borg-Warner Corp., replacing the late **Ben A. Swennes**. Formerly von Linsowe was with Allison Div., General Motors, and J. I. Case Co.

**Milton Rosenberg**: Appointed vice president-engineering, Electronic Memories, Inc., Los Angeles. Rosenberg has been active in the electronic computer and ferrite core fields for over 15 years and is the holder of more than 25 U.S. patents in these fields.

**Dr. Earl R. Lind**: Joins Electro-Mechanical Research, Inc., Sarasota, Fla., as systems analyst, Engineering Dept., Systems Div. Formerly Dr. Lind was a lead engineer, Advanced Electronics Center, General Electric Co.

**Dr. Donald L. Farr**: Former research group engineer, General Dynamics/Astronautics, joins General Precision's Librascope Division, Glendale, Calif. Dr. Farr, as staff engineer in the technical planning group of Librascope's Aerospace Branch, will be engaged in research and design of guidance computers for future space-vehicle applications.

**Paul J. Meeks**: Named associate director, Special Systems organization, Space-General Corp., Glendale, Calif. Previously Meeks was president and general manager of Clary Dynamics, a subsidiary of Clary Corp. **Charles A. Savant**: Named associate director of Systems Analysis and Data Processing Group. Savant joined Space-General Corp. from the Northrop Corp.'s Norair Division.

**Dr. Ralph P. Hudson**: Appointed chief, Heat Division, National Bureau of Standards, U.S. Dept. of Commerce, Washington, D.C. He will continue to serve pro tempore as chief of the Cryogenic Physics Section. **Dr. Yardley Beers** appointed chief, Millimeter-Wave Research Section, Radio Standards Laboratory, Boulder Laboratories, NBS.

## CORRECTION

*In this department of M/R, Oct. 9, we transposed the photos of T. H. Beck, director of engineering at the Aerospace Div. of Ryan Aeronautical Co., and John A. Vaughan, manager of DuMont Military Electronics Dept., Fairchild Camera and Instrument Corp. Our apologies to both.*



## New Product of the Week: Decision Threshold Computer

A DECISION THRESHOLD computer (DTC) which may find widespread application on high-frequency frequency-shift-keyed communication circuits by producing a remarkable improvement in signal detectability is available from Page Communications Engineers, Inc.

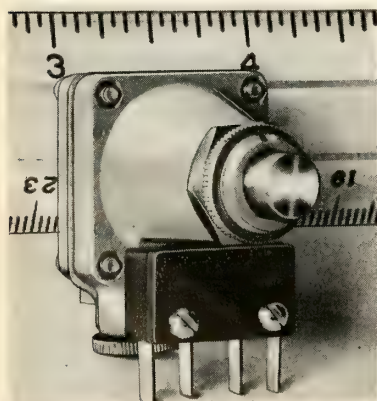
The DTC is an inexpensive device which automatically adjusts, according to predetermined criteria, the binary decision level on a signal perturbed by frequency selective fading. Use of this device has brought about a 30-fold reduction in telegraph and binary data transmission error rates (M/R, Aug. 24, 1959, p. 28).

The DTC offers some protection against interference and international jamming through its ability to make correct decisions if only one of the two frequencies is available. Under certain conditions, it is therefore possible to recover traffic which might otherwise be lost.

Circle No. 225 on Subscriber Service Card

## Pneumatic Timer

A miniature pneumatic timer approximately the size of a standard limit switch is available at Hagen Manufacturing Co. The unit is 1½-in. square and weighs less than 1 oz. It is built for 5 million actuations. Basically a



flush-mounted component, it comes complete with its own universal mounting bracket for use any place in any position. Time range is adjustable from 0.2 to 15 sec. The easily replaced switch is rated at 10 amps. The unit will operate efficiently (within a repeat accuracy of  $\pm 10\%$ ) in temperatures of 32-120°F. It may be used as a combination limit switch and a time delay limit switch.

Circle No. 226 on Subscriber Service Card

## Automatic Welding System

High - production, high - reliability electronic welding of microminiature component modules, fine wire, complex vacuum tube assemblies and other precision applications requiring a multiplicity of different welding energy and electrode force settings, is possible with an automatic welding system, PAWS-1, available from Weldmatic Division/Unitek.

Each system is a completely inte-

grated, mobile work-station designed to maximize speed and product reliability. Up to 10 weld conditions, each consisting of a pre-determined force and energy value, may be tape program sequenced or manually sequenced to correspond to any specific welding instructions required by a module or instrument. The operator inserts the tape and actuates the head only. All force and heat settings are automatically set by the welding system.

Circle No. 227 on Subscriber Service Card

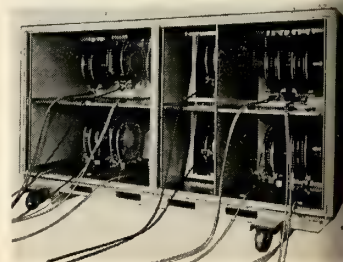
## Rectifier Series

Two series of silicon-controlled rectifiers, including JEDEC types, featuring micro-second switching speeds at a low firing current are available from International Rectifier Corp. JEDEC types 2N1842 through 2N1849, rated at 10 amperes over a PRV range of 20 to 400 volts, operate over a temperature range of from  $-40^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ . The second series, 16RC2 through 16RC40, are rated at 16 amps over a PRV range of 25 to 400 volts. They are electrically, but not mechanically equivalent to JEDEC types 2N6 through 2N688. They operate over a temperature range of from  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

Circle No. 228 on Subscriber Service Card

## Ground Support Reels

Industrial Electrical Works is marketing retractable high-pressure, stainless-steel hose and special mu-



conductor, explosion-proof reels for use in ground support systems and pre-flight testing. Cables and hose are neatly stowed and are immediately available for check-out procedures.

Circle No. 229 on Subscriber Service Card

## Dielectric Strength Tester

A Model 4712 Hypot Mate Tester, for determining dielectric strength of insulating liquids, solids and sheets at potentials to 60 kv, is available from Associated Research, Inc. The test cage of the unit is safety interlocked.

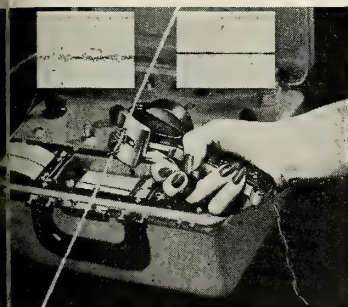


... may be provided with rapid change  
... that accept a full line of insulating  
... materials test-fixtures, making possible  
... electric strength determinations on  
... sheets, tapes, thick solids, encapsulating  
... and potting compounds, laminated  
... sheets, oils and other liquids, and many  
... additional materials. Applicable require-  
... ments of ASTM, MIL and Federal test  
... specifications are fully met.

Circle No. 230 on Subscriber Service Card

## Dynamic Tension Recorder

An electronic recorder to record  
... tension and its changes during all pre-  
... paratory operations of wires, cables,  
... ropes and yarns is available from Ten-  
... nison, Inc. It shows quickly changing



... sions electrically during the prepara-  
... tion of wires and cables at full speed.  
... The recorder operates at two speeds: at  
... 5 and 50 millimeters/sec. Thousandths-  
... of-a-second registration is indicated by  
... separate time-markings. Larger trans-  
... ducers extend the use of the Saxl Ten-  
... sion Recorder for checking the heavier  
... sections of moving glass fibers.

Circle No. 231 on Subscriber Service Card

## Air-Bearing Spindle

Rotational accuracy of one millionth  
... of an inch has been achieved in exter-  
... nally pressurized air-bearing spindles  
... developed by Professional Instruments.  
... Both radial and axial runouts are held  
... to a millionth. The spindles, soon to  
... be marketed under the trade name  
... Precision, use "annular capillaries" to con-  
... trol fluid flow through the bearing,  
... eliminating the need for conventional  
... ports and orifices.

Circle No. 232 on Subscriber Service Card

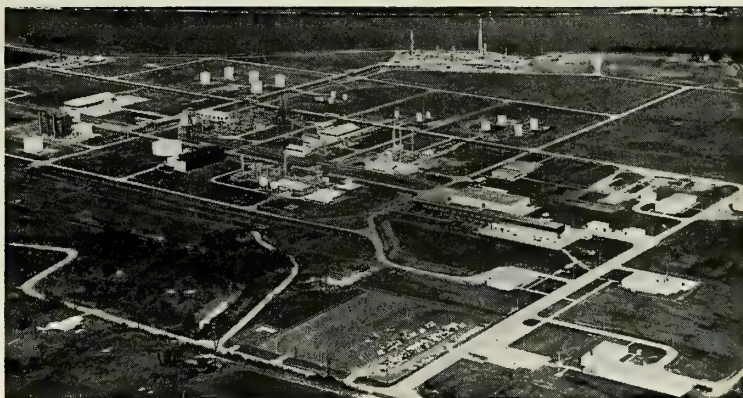
## Double-Pulse Generator

Servo Corp. of America is produc-  
... ing a precision double-pulse generator  
... (240A) providing a multiplicity of  
... separate or mixed output signals. The  
... unit features fast rise time and flexible  
... modular construction. Accurate cali-  
... brated controls make it easy to set up  
... variable output parameters on the in-  
... strument, rather than relying on separ-  
... ate calibration and monitoring equip-  
... ment. High power, accuracy to 0.5%,

... miles and rockets, October 23, 1961



... LEADERS IN PENTABORANE AND BORON FUELS



## MUSKOGEE Oklahoma, U.S.A.

... here's the only large-scale facility for low cost production  
of borane high-energy fuels

At this modern \$35-million government-owned plant, Callery Chemical Com-  
pany is carrying out a current Air Force contract to produce 300,000 pounds of  
Pentaborane. Tonnage shipments of Pentaborane on a regular basis by Callery  
show the feasibility of producing and handling this energetic fuel in volume.  
Callery engineers have worked out the handling and safety techniques re-  
quired for Pentaborane, just as other highly-active materials have been tamed  
since the Space Age began in earnest.

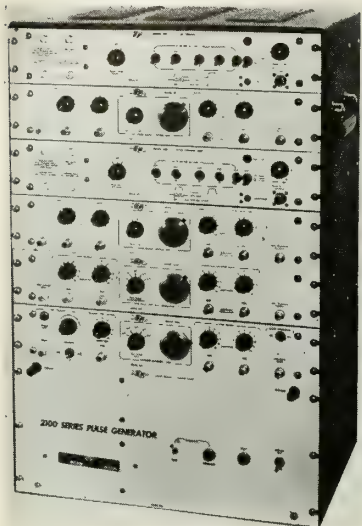
| Oxidizer                      | Specific Impulse<br>(1000 $\rightarrow$ 0.2) |
|-------------------------------|----------------------------------------------|
| OF <sub>2</sub>               | 466                                          |
| F <sub>2</sub>                | 436                                          |
| NF <sub>3</sub>               | 412                                          |
| H <sub>2</sub> O <sub>2</sub> | 405                                          |
| N <sub>2</sub> O <sub>4</sub> | 391                                          |
| ClO <sub>3</sub> F            | 390                                          |
| ClF <sub>3</sub>              | 368                                          |

Take a look at the performance advantages of Pentaborane. The table shows  
the *vacuum specific impulses* for some typical space-storable systems with  
Pentaborane as the fuel. The data are part of a new booklet, "Propellant Per-  
formance Data." Ask for it on your letterhead. Callery's complete technical  
brochure on Pentaborane is newly revised, too—get your copy by calling  
or writing:

## Callery Chemical Company, Defense Products Department

Headquarters: Callery, Pennsylvania • Telephone: Evans City (Pa.) 3510  
West Coast: 15537 Lanark Street, Van Nuys, California • Telephone: STate 1-5761  
Washington, D.C.: 709 duPont Circle Building • Telephone: ADams 4-4200  
Dayton, Ohio: Suite 12, 2600 Far Hills Avenue • Telephone: AXminster 8-1242

Circle No. 11 on Subscriber Service Card



0.02 microsecond rise time, and repetition rate of 100 kc make the general-purpose instrument applicable to a broad range of pulse simulation and control problems.

Circle No. 233 on Subscriber Service Card

## Crystal Detector

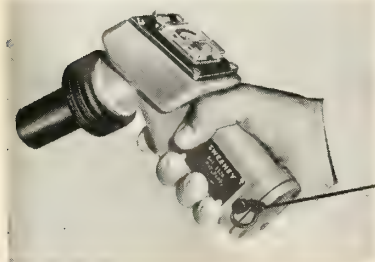
A crystal detector providing flat frequency response of  $\pm 1$  db over the entire 1 to 11 gc range is available from Alfred Electronics. The unit operates from 1 to 12.4 gc, with VSWR of less than 2.2 to 1. Sensitivity is 0.1 volt per milliwatt, maximum input power is 20 mw. Use of the detector permits accurate oscilloscope display of rf component characteristics which vary with frequency. The flat response of the detector can also be used for automatic gain or power control.

Circle No. 234 on Subscriber Service Card

## Static Charge Tester

An instrument for use in detecting the static charge differential that exists between improperly grounded or bonded objects is being produced by B. K. Sweeney Mfg. Co.

Designed primarily as a safety de-



vice for use where inflammable liquids are handled and stored—such as in aircraft, missile, and vehicle refueling areas—the Model SWE-1125 Static Meter features a green-red, "go, no-go" dial face that tells at a glance whether or not the grounding or bonding connections in an area are good.

This battery-powered instrument is voltage-operated and reads electrostatic charge—not resistance. Energy as low as one millimicro joule from the measured source will actuate the indicator.

Circle No. 235 on Subscriber Service Card

## Ultrasonic Ball Pen

An ultrasonic ball-point writing instrument is available from Ultrasonic Industries, Inc. The device, capable of writing at a linear speed of 9000 feet per minute, requires no writing fluids or marking compounds of any sort. It produces high-contrast, high-visibility markings on paper materials. The writing is permanent and as durable as the paper itself.

It can write upside-down or at any other angle of position with respect to the writing surface. It will write in extremes of temperature from absolute zero to 500°F. and higher, in various atmospheres from 100% humid to bone dry, and it is unaffected by dust or other airborne contaminants.

Because of the pen's unique ability to operate in all types of atmospheres, there is no limitation on its use in process control instrumentation.

Circle No. 236 on Subscriber Service Card

## Filament Winding Resins

Two epoxy resins are available from Union Carbide Plastics, for filament winding systems requiring high tensile elongation and good handling characteristics. Bakelite ERL-2256 and ERK-2258 have excellent physical properties and cure well with anhydrides and aromatic amines at room temperature, but are not recommended for use with methyl nadic anhydride. ERL-2256 has a viscosity range of 500-900 cps at room temperature, and ERL-2258—especially developed for filament winders requiring ultra-low viscosity in their work—has a range of 100-500 cps at 25°C.

Circle No. 237 on Subscriber Service Card

## 1000°F Ball Valve

Use of Graphitar seats in McCannaseal models of ball valves produced by Hills-McCanna Co. permits their use at temperatures to 1000°F when handling nonoxidizing liquids or gases and to 700°F for oxidizing reagents. Allow-

able maximum pressure at higher temperatures is dependent upon the valve body materials. At 1000°F, bodies of 316 stainless steel, 300-lb. ASA rating are suitable for pressures to 355 psi; carbon steel for pressures to 80 psi. The same materials in 150 lbs. ASA rating valves are suitable for pressures to 40 psig at 1000°F.

Circle No. 238 on Subscriber Service Card

## Electronic Multiplexer

Operation at both low and high input levels, fast overload recovery and long-term stability are features of ground-station electronic multiplexers available from Texas Instruments, Inc. The all-solid-state unit has sampling rates between 20 and 200 frames per second for 48 50% duty cycle channels of information and one sync channel, with differential inputs ranging between 0 to 5 volts.

Circle No. 239 on Subscriber Service Card

## Pulse and RF Amplifiers

A series of wide-band pulse and radio frequency amplifiers, that feature nanosecond rise times, negligible ringing or overshoot and self-contained power supplies, are available from RHG El-



tronics Laboratory, Inc. Models amplify maximum pulse width from 1000 microseconds, and provide  $< 10$  nanosecond rise times, 0.25 to 10 peak output voltages, rf bandpass from 100 cps to 300 mcs, 20-100 gain, input and output impedances.

Circle No. 240 on Subscriber Service Card

## Isostatic Pressing System

Autoclave Engineers, Inc. has developed an isostatic pressing system attaining high-density, uniform formation of irregularly shaped powder metal or ceramic parts by means of hydraulic pressure. The system is available as a complete package unit, including pumping equipment, compression cylinder, pressure vessel, and instrumentation.

Circle No. 241 on Subscriber Service Card



## Heliarc Torch

A featherweight Heliarc welding torch with the shortest head of any torch has been introduced by Linde Co. The 2½-oz. HW-24 is ideal for hard-to-reach joints. Average head length of 1 in. enables an operator to weld areas with only 1¼ in. clearance and permits improved vision of the weld puddle. Air-cooled, it is rated at 75 lbs continuous-duty with high-frequency stabilized a-c or straight polarity. It utilizes 0.020-0.040- and 1/16-in. electrodes pure or thoriated tungsten with 7/16-in. range of electrode adjustment.

Circle No. 242 on Subscriber Service Card

## new literature

**DEVIATION METER**—A technical bulletin describing the Model 400 Frequency-Modulation Deviation Meter is now available from Advanced Measurement Instruments, Inc. The meter measures peak positive or negative deviation of composite wave shapes with better than 2% accuracy. It enables carrier frequency to be read directly within 0.5% from 20 to 1000 mc, and indicates peak deviation directly to 10 kc.

Circle No. 200 on Subscriber Service Card

**OLID LUBRICANTS**—The theory and use of solid lubricants is thoroughly discussed in a brochure published by Alpha-Molykote Corp. Such barriers to effective lubrication as galling, seizing, extreme pressures, high friction, chemical reaction, temperature extremes and environments are covered; there are explanations of how solid lubricants can overcome them.

Circle No. 201 on Subscriber Service Card

**OLID-STATE CARRIER**—A 12-page brochure describing Collins Radio's MX-106 Transistorized Carrier has been released by Alpha Corp., a division of Collins. The MX-106 carrier can produce up to 600 voice channels over microwave radio. Use of all-solid-state components has reduced size, lowered power requirements and greatly increased reliability of the equipment.

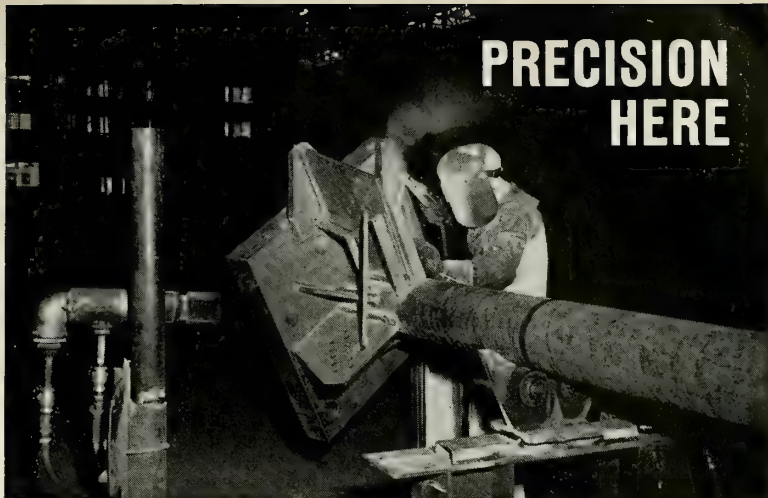
Circle No. 202 on Subscriber Service Card

**HEATING UNIT**—Lindberg Engineering Co. has published Bulletin 51, detailing the features and equipment of a Radio Frequency Heating Unit—Model LI-15D-1. The unit is a vacuum-tube type converter designed to convert power line energy to high-frequency electrical energy suitable for induction heating.

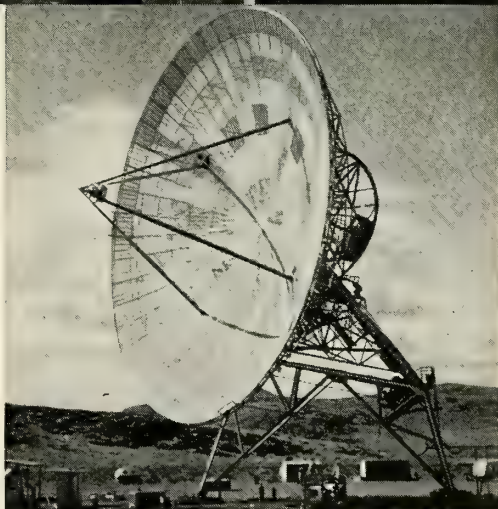
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ships and rockets, October 23, 1961

## PRECISION HERE



## MEANS ACCURACY HERE



Careful welding of massive structures to precise tolerances is just one of the skills Blaw-Knox contributes to provide accurate operation of some of the world's largest radar and tracking antennas and radio telescopes.

Only the skill that comes from many years' experience provides the master craftsman touch that enables Blaw-Knox antennas to be built . . . to the close surface tolerances and to the fine pointing accuracies required by our customers. And Blaw-Knox engineering assures the right design to make the best use of those skills and Blaw-Knox unique shop facilities.

Blaw-Knox designs and builds to close tolerances, with minimum deflections, at reasonable cost—fabricates in steel, special alloys and aluminum—designs to your needs, or builds to your specifications. Complete research, engineering, testing and fabricating facilities are at your disposal. Write or phone today for immediate attention. Blaw-Knox Company, Pittsburgh 38, Pennsylvania. Phone, STerling 1-2700.

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Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes Towers and Special Structures • POWER: Power Plant Specialties and Valves

Circle No. 12 on Subscriber Service Card



# contracts

## NASA

- \$666,471—Gurtler, Hébert and Co., Inc., New Orleans, from Marshall SFC, for rehabilitation and modification of *Saturn* launch vehicle assembly plant in New Orleans.
- \$77,288—Mobile Aerial Towers, Inc., Ft. Wayne, Ind., for services and materials to design, fabricate and deliver a pilot's capsule egress tower.
- \$75,000—Aerojet-General Corp., Azusa, Calif., for services and materials to furnish two-phase forced-convection mercury corrosion loops for Lewis Research Center.
- \$68,500—Hughes Aircraft Co., Culver City, Calif., from Marshall SFC, for development of a rubber-like sealant for use with super-cold liquid propellants.
- \$65,000—Lockheed Missiles & Space Co., Palo Alto, Calif., from Marshall SFC, for systematic analysis of interplanetary spacecraft orbits with regard to future mission possibilities.

## MISCELLANEOUS

- \$12,500,000—Autonetics Div., North American Aviation, from International Business Machines Corp., for terrain-avoidance computers as part of the B-52 modernization program.
- \$7,450,000—Lockheed Missiles and Space Co., Sunnyvale, Calif., from Navy, for advanced *Polaris* development program; \$1,290,000 from Air Force, for satellite program support.
- \$5,000,000—Western Gear Corp., Lynwood, Calif., from Martin/Denver for manufacture of shock isolation systems for silo installations of *Titan II*.
- \$4,035,000—Elgin National Watch Co., Elgin, Ill., for production of *Bullpup*, *Sparrow*, *Sidewinder*, and *Tartar* missiles (four contracts).
- \$350,000—High Vacuum Equipment Corp., a subsidiary of Robinson Technical Products, Inc., Hingham, Mass., for space simulation facility capable of testing a four-ton satellite.
- \$331,000—Univac Div., Sperry Rand Corp., St. Paul, Minn., from The Boeing Co., for automatic antenna couplers.
- \$320,000—Shielding, Inc., Philadelphia, from General Electric Co., for a manufacturing, controlled environment facility to be installed in GE's Space Technology Center, Valley Forge, Pa.

## NAVY

- \$6,500,000—Sperry Gyroscope Co., from BuWeps, for production of "silent" underwater detection systems.
- \$2,724,094—Cameron Iron Works, Houston, for boosters and sustainers for *Terrier* missiles.
- \$1,510,862—Sylvania Electric Products, Inc., Buffalo, N.Y., for research and development on communications equipment.
- \$1,250,270—Westinghouse Electric Corp., Baltimore, for design and fabrication of underwater-launch sea-current recording systems for *Polaris* launchers.
- \$1,196,325—Eastman Kodak Co., Rochester, N.Y., for fuzes for *Sidewinder* missiles.
- \$444,427—Maxson Electronics Corp., New York City, from BuWeps, for production of adoption kits for *Talos*; \$170,648 from U.S. Naval Training Device Center, for a naval training device.
- \$50,000—The deHavilland Aircraft of Canada, Ltd., Ontario, for design, development, and construction of two 500-ft. erectable antennas for satellite applications.
- \$26,760—Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y., for a theoretical investigation of the forces and moments of an oscillating hydrofoil.
- Space Technology Laboratories, Inc., Los Angeles, from Naval Ordnance Laboratories, Corona, Calif., for study of advanced telemetry techniques to develop

improved methods of synchronizing telemetry systems in rocket flights. Amount disclosed.

## ARMY

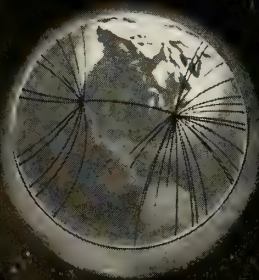
- \$1,746,429—Douglas Aircraft Co., Charlotte, N.C., for production of items for *Nike Hercules* air defense missile system.
- \$1,700,000—Sylvania Electric Products, Inc., Waltham, Mass., for *Advent* communications satellite antenna systems.
- \$1,565,000—Western Electric Co., New York City, for *Nike-Hercules* missile guidance sections and related components; \$1,500,000 for technical publications relating to the *Nike* program.
- \$1,500,000—Adler Electronics, Inc., from General Dynamics/Electronics, for design and production of air- and ground-transposable area communications systems.
- \$1,392,799—The Korfund Co., Inc., Long Island, N.Y., for shock isolation development for *Titan II* missile launch facilities at Davis-Monthan AFB, McConnell AFB, and Vandenberg AFB.
- \$1,167,093—Mine Safety Appliances Co., Pittsburgh, for vapor detection systems for *Titan II* missile launch facilities at Davis-Monthan AFB, McConnell AFB, and Vandenberg AFB.
- \$961,725—Kurz & Root Co., Appleton, Wis., for design and manufacture of diesel generator sets for aircraft and missile bases.
- \$191,154—Aluminum Co. of America, Washington, D.C., for development of aluminum-base alloys suitable for construction of large solid-propellant rockets.
- \$114,000—Douglas Aircraft Co., Santa Monica, Calif., for research and development of improved *Honest John* rocket system.
- Electro-Optical Div., Perkin-Elmer Co., Norwalk, Conn., from ARGMA, for study and development of special instrumentation to study missile re-entry for use by the Canadian Armament Research Development Establishment (CARD) Quebec City. No amount disclosed.

## AIR FORCE

- \$43,900,000—Lockheed Missiles and Space Co., Sunnyvale, Calif., for continued production of *Agena* space vehicles used to propel *Discoverer* and other satellites.
- \$3,800,000—AVCO's Lycoming Div., Stratford, Conn., from Aerojet-General Corp., for titanium and steel rocket chambers for the *Minuteman ICBM*.
- \$750,000—United ElectroDynamics, Inc., Los Angeles, for advanced seismic research and analysis for various agencies of Air Force (five contracts).
- \$577,548—Collins Radio Co., Cedar Rapids, Iowa, for airborne navigational equipment.
- \$500,000—ACF Electronics Div., ACF Industries, Inc., Riverdale, Md., from Naval Ordnance Laboratories, for radar beacons for *Hound Dog* guided missile system.
- \$325,000—Telecomputing Corp.'s Permutit Div., Denver, from The Boeing Co., for design, development, and production of batteries for use in *Minuteman* launch crew training program.
- \$91,565—Polytechnic Institute of Brooklyn, from OSF, for a study of instabilities in liquid-propellant rocket motors.
- \$50,000—General Motors Corp., AC Spark Plug Div., Flint, Mich., for in-service engineering for the inertial guidance system and associated AGE of the *Thor* weapon system.
- The Pfaudler Co., a division of Permutit Inc., Rochester, N.Y., for preliminary research in the field of high-temperature metallic coatings used in entry aerospace vehicles. No amount disclosed.

41 years' experience in building and operating global communication networks (serving 99 countries) gives RCA unique capabilities in space-age communications. Talk with us if your responsibility includes the development of international communication systems between command and satellite tracking stations.

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## Vela Hotel

(Continued from page 13)

estimated at about 100 million km for X-rays and 10,000 to 1,000,000 km for gamma and neutron radiation.

Only about one percent of the total energy of a detonation will be carried away by gamma and neutron radiation, the remainder being thermal X-rays. Neutron detection is easiest, but is too short-range in nature to be of much value except perhaps as an additional verification in cases of doubt.

• **X-ray detectors**—A total of 10 X-ray detectors will be uniformly spaced over the surface of the satellite, with at least five looking in any one direction to provide high orders of coincidence. These detectors are thin dome-like plastic fluors absorbing the X-rays and changing them to visible light measured by standard photomultiplier tubes.

Shielding of the photomultiplier tubes from sunlight is accomplished by placing a thin beryllium or aluminum cover over the fluor. The shield must be thin enough so that it does not interfere with or absorb the soft X-rays, but must still be opaque to sunlight.

Nuclear explosions would produce light pulses of less than one microsecond duration in each detector. Intensity of the pulses would be directly proportional to the yield of the weapon but inversely proportional to the square of the distance from the weapon.

Seven bias levels will be built into the electronics, adjustable on command from the earth, in order to select the desired intensity level for triggering the detectors.

• **Gamma and neutron rays**—Six gamma-ray detectors will also be spaced uniformly about the *Vela Hotel* payload, but beneath the exterior skin of the satellite. Each of these will be a solid plastic fluor about 3 in. in diameter by 2 in. long and mounted on a photomultiplier tube.

The gamma detection fluor will be covered by about 1/8-in. of aluminum to shield the tube from low-energy background radiation. Another similarity with the X-ray detection method is the electronic circuitry, which will have seven bias levels and multiple coincidence circuits to insure elimination of false alarms.

The neutron detection system differs from the other two. It consists of two or more adjacent BF<sub>3</sub> neutron counters, surrounded by a common moderator of ten lbs. of CH<sub>2</sub> and located under the exterior surface of the satellite.

• **Guard counters**—In addition to detectors for the three types of radiation expected from a nuclear detona-

tion, 10 guard counters will be placed aboard the satellite to help identify bursts of charged particles produced within the satellite by cosmic rays and resulting in triggering several of the X-ray detectors.

The guard counters, working in conjunction with the X-ray detectors, will probably consist of a plastic fluor arranged about each X-ray detector so that any particles passing from within the satellite out through the X-ray detector will have to pass through the guard counter.

LASL feels that the combination of X-ray, gamma-ray and neutron detectors, as well as the guard counters, will supply valuable information—not only when struck by specific types of radiation anticipated, but also in diagnosing a complicated situation such as a high-energy plasma of protons and electrons ejected from the sun and striking the satellite.

One note of caution has been sounded—it may be possible to shield nuclear explosions in order to reduce their direct radiation. The problem would affect *Vela Hotel* mostly in loss of range, should such shielding in space prove feasible. It has already been suggested that studies be made to find ways of detecting even shielded explosions. ♦♦

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# On Booze, Blondes and Bashes

**N**OW THAT the silly season is nearing its end, it is perhaps time the industry gave some deep thought to this question of technical and pseudo-technical meetings and just what it expects from them.

We have watched with some sympathy in recent weeks as our friends from the West shuttled back and forth to the Army association meeting in Washington, the Air Force party-going in Philadelphia and the Space Flight Report to the Nation in New York. Their explanations to their wives probably would make far more interesting reading than many of the technical papers so laboriously presented at the meetings.

We also have watched, with somewhat less sympathy, as our editors burrowed through hundreds of pounds of frequently repetitious papers and courted ulcers on the scotch and bourbon circuit.

Last week, for example, found no less than seven of our editors covering the big American Rocket Society meeting in New York, two staffing the National Aeronautic and Space Engineering and Manufacturing Meeting of the Society of Automotive Engineers in Los Angeles, and one attending the National Electronics Conference and Exhibition in Chicago.

We're not complaining. Part of our job is to attend these meetings for you. Since the beginning of the year, our editors have covered more than 30 of the big ones.

But it does raise a question, as we encounter the same thinly disguised papers presented again and again, as to the worth of so many time-consuming conferences. The money expended also is considerable.

While we were on the Boeing stand at the New York Coliseum last week, a young lady rushed up and shoved a bill in our hand for more than \$1200. It covered electrical installation charges for the exhibit, which itself was an obviously expensive item. We thoughtfully placed the bill in the center of a display showing Boeing's capability in manufacturing huge tank sections and we hope it gets paid.

In Philadelphia, the customer relations representative of a major West Coast missile/space manufacturer told us the firm's hospitality suite for the Air Force Association meeting was budgeted at about \$5000. Its display in the exhibition cost a whacking additional sum. The elaborate buffet-dancing parties of several other manufacturers undoubtedly enriched Philadelphia caterers, musicians and hotel owners by well over \$100,000.

Industry prestige at AFA, meanwhile, was enhanced by at least one fist fight and the drunken antics of several Air Force generals, corporate presidents and vice presidents and, alas, members of the press.

Is all this worthwhile? We doubt it.

The incoming president of the American Rocket Society, Dr. William H. Pickering, had something to say on the subject in New York. Dr. Pickering pointed out that industry spends \$100 million annually—\$50 million in direct costs and "at least" an equal amount in indirect costs—to attend technical society meetings. He called on the societies to hold meetings only when sufficient timely and high-quality papers are available. The ARS president urged industry and government to submit only truly significant papers and to be more selective in the people they send to meetings.

**W**HAT CAN A COMPANY hope to accomplish at a technical meeting and exhibition? An interesting survey was released this week by Clapp & Poliak, Inc., producers of a number of the nation's industrial shows. It was conducted at the Design Engineering Show in Detroit's Cobo Hall earlier this year. It indicated nine major areas for improvement. We won't attempt to cover them all here but some of the comments are enlightening:

"I was irritated, after coming 2000 miles for information, to find many exhibitors with salesmen in attendance who could not give me the technical data desired."

"Suggest to the exhibitors that the platinum blonde female who has no knowledge of the products beyond the canned speech and who monopolizes the time and attention of the visitors adds little to the product presentation."

"Despite the millions of dollars spent, I believe some of the manufacturers could have made it more interesting by having more of their products on hand and more working models—too many booths were taken up purely as advertisement."

"Exhibitors should be encouraged to distribute more engineering data such as dimensions, finishes, materials. . . . Too much of the literature is strictly propaganda."

With the survey, some good advice on exhibiting is provided in a publication entitled "What They Want." Single copies are available without charge from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

When making decisions on next year's society and association meetings, firms in the missile/space industry could do a lot worse than to ponder the words of Dr. Pickering and the Messrs. Clapp & Poliak.

Fewer meetings, more worthwhile papers, more useful exhibits, less booze and fewer extravagant parties would do much to enhance not only the industry's image before Congress and the public, but its technical progress.

**William J. Coughlin**



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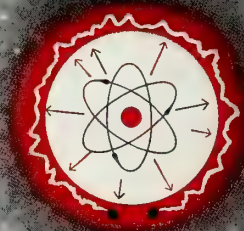
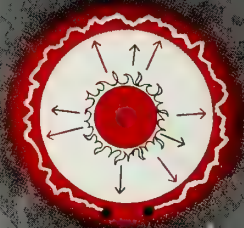
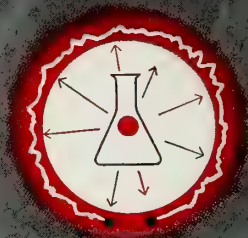


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# missiles and rockets

THE MISSILE SPACE WEEKLY



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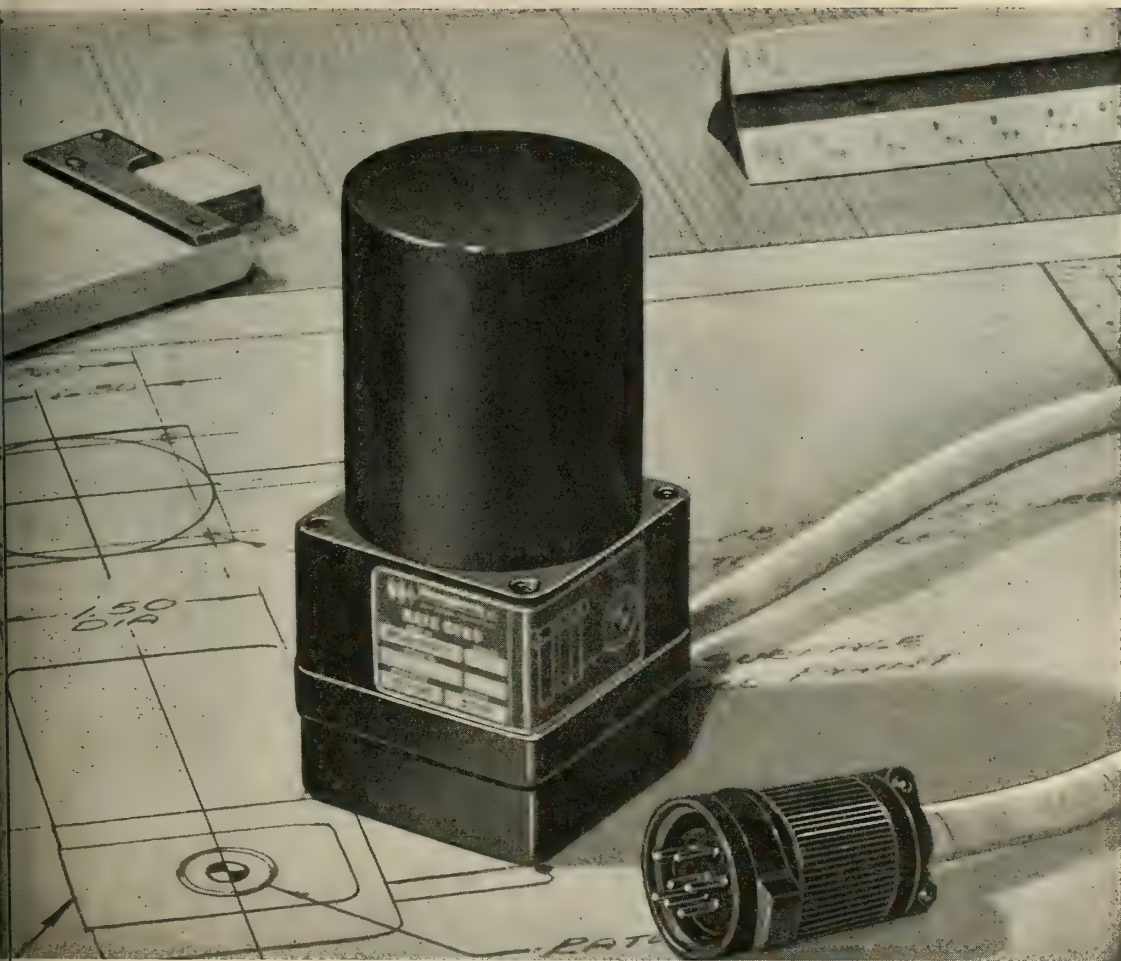
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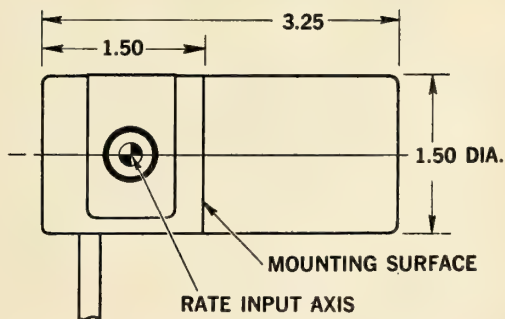


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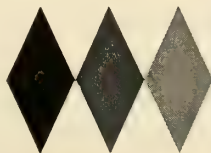
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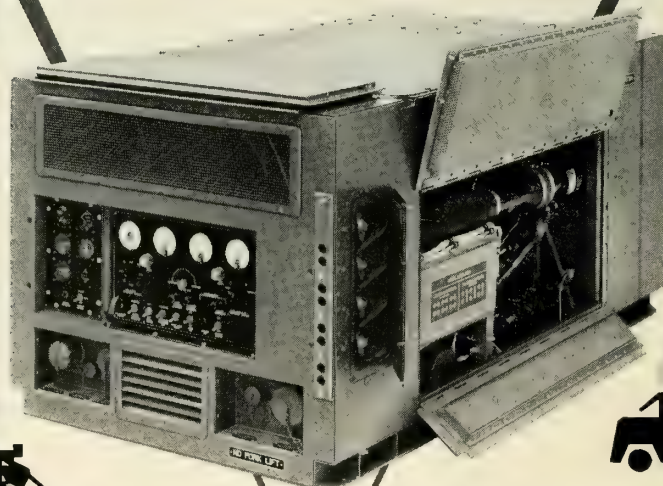
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# missiles and rockets

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October 30, 1961

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missiles and rockets, October 30, 1961

## THE COVER

Four inert Douglas Skybolt air-launched  
 ballistic missiles slung under Air Force  
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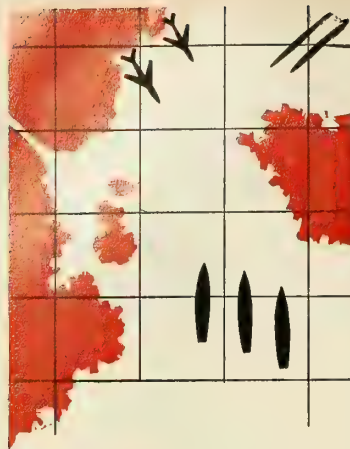
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## letters

### Counting Heads at ARS

To the Editor:

Hold! Scrub! In M/R Oct. 16 you stated that there were 15,000 at the New York ARS meeting. Last word I had was that there were only around 3000 registrants. Are you reporting (ARS Executive Secretary James J.) Harford's Hopes or reality? Your caption on the front cover should have read "Report from Biggest Bust of an ARS Meeting." Last year's ARS meeting in Washington was really bigger. If you want to report grass roots (or pad roots) feelings, I think that it reflects a growing discontent about too many meetings. Reactions of the non-trade press the nation wide also indicate an "ackish" attitude. You can't orbit a golden egg too often.

Fact Not Fancy

M/R said "more than 15,000 scientists and engineers attended," not registered. ARS says the exact registration was 9111, just halfway between the writer's 3000 and 15,000. In addition, there were 37,000 paid public admissions and close to 15,000 "freebies" (exhibitors, etc.), according to ARS, for a total attendance of around 60,000. Our Oct. 23 editorial expresses our feelings about the overabundance of technical meetings.—Ed.

### Russian Boosters

To the Editor:

It appears to me that Mr. Dandridge M. Cole in his article on Red boosters ("Reds may Be Using Saturn-Class Boosters," M/R, Oct. 9, p. 40) has confused *Sputniks VIII* and *XI*. He uses the payloads of the *Venus Probe* and the *Vostoks* interchangeably in his calculations and comments that they probably used the same booster.

According to all the sources I've found, the payload of *Sputnik VIII* was 14,292 lbs. and the *Venus Probe* was 1419 lbs., making a total of 15,711 lbs. of combined payload in one boost. The payload of the *Vostoks* was 10,395 lbs. (*Sputniks XI* and *XII*).

In calculating boost in thrusts, it would appear that there have been three "classes" since *Sputnik III*:

Class A—payload 3000 lbs.—*Sputnik III*.

Class B—payload 10,000 lbs.—*Sputniks IV, V, VI, IX, X, XI & XII*.

Class C—payload 16,000 lbs.—*Sputniks VII & VIII*.

Using Mr. Cole's figure of 70 for a ratio of gross take-off weight to payload weight, and estimating the ratio of take-off thrust to take-off weight to be 1-3, the thrust for Class B would be 910,000 lbs.

Studying some *Atlas* performance figures, it appears to me that 60 would be a more up-to-date ratio. This would give a Class B (*Vostok*) thrust of 780,000 lbs., which is the accepted figure.

Now as to *Sputniks VII* and *VIII*, it

appears that this is a new breed of booster and probably not used for *Vostok* for this reason (the USSR had five successful type B launchings before *Vostok*). Using the ratio of 60 and 1-3, explained above, the type C thrust would be 1.25 million lbs. As to the number of stages for the *Venus Probe*, it appears to me that one of the *Sputnik VIII* "payload" was used as the rocket for the space probe itself. If we used the "old" module of *Class A* (10 K lbs.) for guidance, telemetry, 5000 lbs. would remain for this rocket. In this sense it is a three-stage vehicle.

In regards to using a stock 200-K engine, this would give us the following clusters:

Class A—3

Class B—4

Class C—6

Maybe the recent Pacific tests are Class D, with 8 stock engines and approximately 1.6 meg. lb. thrust. This would be orbiting (in the USSR stock 65°, 150 orbit) a payload of approximately 20 million lbs.!

In any event it seems certain that the Russians have either a booster of approximately 1.25 meg. lbs. thrust or a hydrogen-fueled upper stage.

John B. Wilsch  
RCA Service Center  
Patrick AFB, Fla.

To the Editor:

Dandridge Cole's interesting article leads me to suggest the possibility that the Reds may have been getting around the problem of huge pumping systems by using solid-propellant gas generators instead of these mechanical monsters pressurizing their liquids.

I was amused by the inadvertent use of "circumlunar" to "circumunar" in the last sentence of the article. Could have been a slip toward "circlemoon." This reminds me: when are we going to orbit the moon, anyway? This task seems as a more important prelude to "on-the-moon" than most people will admit.

A. T. Camp  
Assistant Vice President  
and Chief Staff Scientist  
Grand Central Rocket Company  
Redlands, Calif.

### Soldering Education

To the Editor:

I read with great interest your editorial entitled "The Girl With the Soldering Iron" (M/R, Feb. 27). I am also in complete agreement with your thoughts on the general philosophy regarding the critical nature of wiring and soldering operations performed by personnel on the assembly line.

Recently we developed a formal training program in soldering technique for the Baltimore Divisions of Westinghouse. This program has been completely successful. A condensed version of a manual that I completed on the program

missiles and rockets, October 30, 1958



nted in the Sept. 8 issue of *Electronics* magazine.

The primary purpose for writing, however, is to seek permission from you to incorporate your editorial in the passout material which we give to each trainee at the outset of the 20-hour soldering course. Consider it to be one of the most succinct and effective writings on the subject that I have encountered.

S. W. Mahon  
Education and Training  
Westinghouse Electric Corp.  
Baltimore

anks and permission granted.—Ed.

## ound Reduction

the Editor:

Your Sept. 25 TECHNICAL COUNTDOWN mentions concern about excessive noise on Saturn launch pad due to the use of dry deflector. Comparisons are drawn to a water-cooled static test facility which experiences a considerable sound attenuation due to cooling water on the deflector. The reporter of this obviously does not know what he is talking about. Unlike on a static test stand, the maximum sound emission at a launch pad occurs when the vehicle is in the air and ascending. Obviously, a water-cooled deflector does not reduce a sound of 204 db total sound power level if the source is 500 or 1000 ft. above the pad.

Georg von Tiesenhausen  
Huntsville, Ala.

The information in the news item was offered to one of our editors by a rather important Marshall Space Flight Center official. This man sought out our editor, who was in Huntsville on another matter, because he was worried about rumors that NASA Headquarters was considering eliminating the deflector cooling water.—Ed.

## Advanced Thinking

The Editor:

Many thanks for "Practical Anti-Gravity Still Far Off" (M/R, Sept. 11, p. 28).

The major problems are the enormous amounts of controlled energy required and the very low gravitic permeability of free space.

Feasibility studies in producing matter with much higher permeabilities would seem to be a fruitful field for future breakthroughs. It may well be that high gravitic permeability is a further property of super-density high-temperature plasma.

Perhaps this is straining the magnetic analogy a bit too far, but the majority of modern electrical items could never have become a practical reality without ferromagnetic and the high-permeability alloys.

Advanced-thinking articles of this nature are greatly appreciated. May we look forward to one on methods of interstellar communication?

A. T. Lawton  
Fairley Engineering Limited  
Hounslow, Middlesex,  
United Kingdom

You may indeed.—Ed.

files and rockets, October 30, 1961



KEYSTONE OF INDUSTRY

## New Partners in Industrial Growth



General Electric chooses Pennsylvania as the site for its new Space Technology Center



"We made a nationwide study before selecting Greater Philadelphia for our permanent home," says H. W. Paige, General Manager of General Electric's Missile & Space Vehicle Department.

The decision to build this Space Technology Center near Valley Forge was influenced by a number of factors. "We were able to hire many of our 1500 scientists and engineers within a 100-mile radius, and we found an abundance of technically competent small businesses to do subcontract work. Excellent air and surface transportation provides easy access to missile launch sites, defense establishments and other major defense and space contractors.

"The attractive residential communities, outstanding schools, colleges and cultural activities; and Philadelphia's dynamic program of community improvement—which should continue to enhance

the area's attractiveness to our professional personnel—also influenced our decision.

"Building this 800,000 sq. ft. center, while continuing to occupy a 600,000 sq. ft. facility in Philadelphia's 'University City' is proof we believe Greater Philadelphia is admirably suited to the needs of a modern research and development business."

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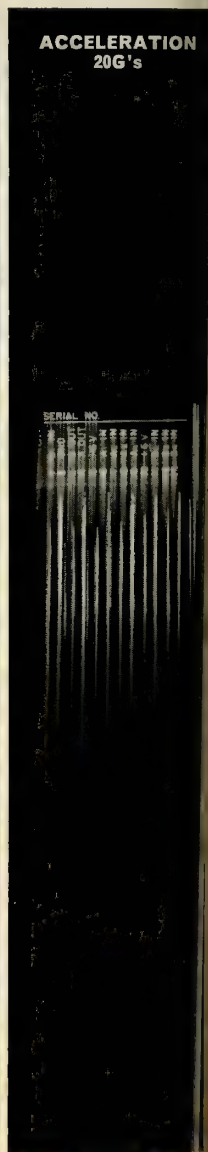
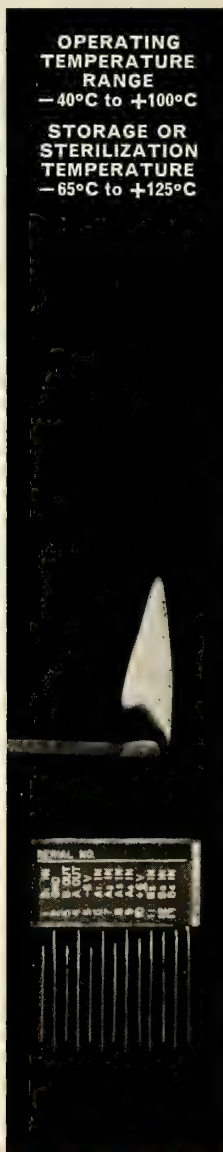
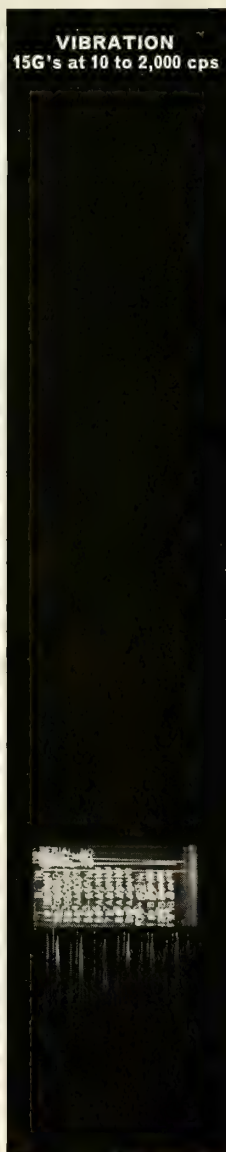
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# The Countdown

## WASHINGTON

### S. H-Bomb Atmospheric Tests

Outlook for resumption of missile nuclear warhead tests by the U.S. is now January—next spring at the latest. The U.S. Pacific nuclear test range in the Marshall Islands needs an estimated four to six months to get prepared for new tests. Meantime, it's possible atmospheric tests of smaller weapons could be conducted in Nevada. One of the main reasons for the new tests is checking out the Nike-Zeus antimissile missile—including its nuclear warhead. Another: checking out improved warheads for U.S. strategic missiles.

### DOD Questions Sergeant's Future

The Defense Department, in surveying all current missile systems for the FY '63 budget, is taking a particularly sharp look at the Sperry *Sergeant*. Some DOD officials are understood to feel the 75-mile-range tactical missile is not needed. *Sergeant* is already in production and scheduled for deployment early next year.

### Minuteman: How Many in FY '63?

The final decision on how many additional *Minutemen* will be included in the FY '63 budget is still open. The debate is reported to have narrowed to whether two squadrons or none will be added to the 12 already authorized through the current fiscal year. One possibility is that even though more production is not included in the budget additional silos will be as a form of insurance.

### Bomarc B's North of the Border

The first operational Boeing *Bomarc B*'s are being deployed at Royal Canadian Air Force bases in Canada. Two squadrons—28 missiles apiece—are being delivered to the bases at North Bay and La Macaza, Quebec. A total of six *Bomarc B* squadrons are being deployed in the continental United States.

### Ranger II Slips Further

The launching of NASA's *Ranger II* space probe has slipped at least a month, into November. The slippage is reported to have been caused by hydraulic system difficulties in the *Agena* second stage of the *Atlas-Agena* boosters used in the program. The first launching of a *Ranger* failed in August.

## INDUSTRY

### NASA Seeks To Spread Space Work

The national space administration wants to increase the number of space contracts let with firms in the Midwest, Southwest and Rocky Mountain Area. A \$250,000 contract has been signed with the Midwest Research Institute in Kansas City, Mo., to inform NASA of the industrial capability of the three regions.

missiles and rockets, October 30, 1961

## Contracts for Shrike

The Navy has begun to let contracts on its new *Shrike* missile system, formerly known as *ARM*. The air-to-surface anti-radiation missile has been under development by NOTS, China Lake, Calif. However, Texas Instruments has now been chosen to provide developmental guidance and control assemblies for the *Shrike* system. Size of contract: \$1,570,504.

## Scramble at Jackass Flats

A hot industry competition is on for the NASA contract to build a second nuclear rocket engine test stand at the National Nuclear Rocket Development Center in Nevada. Twenty-two firms have submitted bids for the job. Value of the contract: about \$8 million.

## Anti-negotiated Contract Bill Readied

The House Armed Services Investigations Subcommittee is preparing legislation aimed at curbing negotiated procurement. The bill is scheduled to be presented to the full committee for action in January. Subcommittee studies show that more than \$8 billion in sole-source procurement contracts were let by the Pentagon over the last two years.

## Just Dial Telestar

AT&T has decided on a name for its R&D communication satellites which NASA will begin launching next year. They will be called *Telestars*. Plans now call for launching four of them.

## INTERNATIONAL

### French 'Precious Stones'

France is now hopeful of orbiting a satellite weighing from 110 to 175 lbs. by 1963-64 period, using a combination of rockets named after precious stones. The big boosters go under the names *Emeraude*, *Saphir* and *Diamant*, weighing upwards of 25 tons, measuring 29 ft. in length or more and liquid-fueled. Uppers stages would be solid-fueled.

### Reluctant Swedes

Sweden is understood to be unhappy about joining the European *Blue Streak* project because it lost out to West Germany in building the third stage. Sweden wanted to use its Flygmotor VR-3 for the job, while West Germany has no hardware.

## Overseas Pipeline

Russia is reported to have set up a new Laboratory of Bio-Telemetry Engineering for man-in-space. . . . Creation of a National Center for Space Research (counterpart to NASA) with an initial yearly budget of about \$17 million has won approval in the French National Assembly. . . . In Britain, Schlumberger Inc. is acquiring a majority interest in the big Solartron Electronic Group Ltd. for about \$5.5 million from Firth Cleveland.

# The Missile/Space Week

## Shots of the Week

The Navy *Polaris* and Air Force *Midas* took significant forward strides last week.

- For the first time, a 1500-mile *Polaris A-2* was fired from a submerged submarine, the *Ethan Allen*. The flight of the 30-ft. missile on Oct. 23 appeared to be successful. But there was no confirmation from the Navy, under a DOD-imposed secrecy rule.

- A *Midas IV* satellite fired into orbit from Vandenberg AFB, Calif., Oct. 21 reportedly detected the exhaust of a *Titan* launched Oct. 24 from Cape Canaveral within two minutes of ignition. Test results of the infrared missile warning system again were kept secret.

- The *Atlas-Agena B* which launched *Midas IV* also carried piggy-back into orbit a 75-lb. package containing 350 million copper dipoles in the Project *West Ford* radio communications experiment. (See photo.)

- On Oct. 23, the Russians fired their seventh large booster rocket into the Pacific.

- The Air Force failed to orbit *Discoverer XXXIII* on Oct. 23 when the *Agenda* second stage apparently shut down prematurely.

## Nuclear Rocket Flight Test Seen Possible by 1966-67

Dr. Glenn T. Seaborg, AEC chairman, predicted this week that the first flight tests of a nuclear-powered *Nerva* rocket could be conducted by 1966 or 1967.

He said the *Nerva* upper stage could increase the payload of a *Saturn* booster two or three times.

AEC recently awarded contracts to Aerojet-General and Westinghouse to develop the first *Nerva* engines.

## Rauth Heads Titan Push

J. Donald Rauth, Vice President of Martin Co.'s Nuclear Division, has been named to head the firm's entire *Titan* missile development program.

Rauth will make his headquarters in Denver and will report directly to Martin Co. President William E.

Bergen. He will supervise research and development, flight testing, base activation and final checkout and delivery of all *Titan* missile and space booster systems.

The Martin Co. has also announced that it has changed the name of its Cocoa Division in Cocoa Beach, Fla., to the Canaveral Division.

## Apollo Effort Appraised

The National Science Foundation has launched a study to determine whether the nation might be pouring too much of its resources and skilled manpower into the *Apollo* program.

This was disclosed by Dr. Alan

T. Waterman, Foundation Director who said that the study would see to learn whether emphasis on landing an American on the moon by 1970 might deprive such key projects as cancer research of needed resources.

The study will be made by the Foundation's new Science Resource Planning Office.

Foundation officials report that the study will continue for several years with the first results due in a few months.

It is being made under broad legislative authority which empowers the Foundation to report to government agencies on the scientific capability of the U. S.



## West Ford Dipoles—Did They Orbit?

SUCCESS OF FIRST Project West Ford experiment was in doubt last week as the Force reported that radar had failed to pick up the band of 350 million dipoles supposedly dispersed in space (see diagram above). There was a possibility they were ejected from a package carried piggy-back by *Midas IV* Oct. 21.



## Screening Space Data

A way to compress a vast amount of space-derived data into compact form for transmission to ground stations is being developed by IBM scientists.

The scheme is to transmit data by exception." If a satellite is sent off with a sensor which measures space radiation, the data transmitter can be instructed to stay off the air until it recognizes that it is getting radiation readings exceeding pre-set limits.

"In transmissions using the data-compact techniques, redundant information is removed from the messages before they are broadcast from the space vehicle," according to Dr. Herman Blasbalg of the Federal Systems Division's Communications Systems Center. "Only the essentials are transmitted."

Blasbalg confirmed that by means of such advanced message-coding techniques, more data can be transmitted from a space vehicle than has ever been possible—and less of the already crowded radio spectrum needed.

## U.S. 7 Points for Space

The Kennedy Administration has proposed a seven-point program to guarantee peace and world cooperation in space.

The program—which will be presented to the United Nations—calls for:

- Explicit confirmation that the U.N. Charter applies to limits of space exploration.
- A declaration that space and heavenly bodies are not subject to claims of national sovereignty.
- An international system of registering all objects launched into space.
- A specialized space unit in the United Nations Secretariat.
- A world weather-watch using satellites.
- A cooperative search for ways to modify weather.
- A global system of communications to link the world by telegraph, telephone, radio and television.

## Russians Propose Earth Halo

Two Soviet scientists have suggested creating Saturn-like rings in space around the earth in order to modify weather on a grand scale.

Their idea, involving the orbiting of several hundred thousand tons of powder, was described in a recent issue of the Soviet Economic Gazette.

"Let us assume that we are able to create a ring around our planet something like that around Saturn," the two scientists said.

"If the particles that make up this ring reflect sunlight well enough, then intelligent orientation of this unique mirror might change the climate of many regions of the earth in the desired direction."

## Epilepsy in Space?

Evidence that astronauts may become temporary epileptics in certain circumstances due to vibrations and accelerational forces of rocket boosters is reported by UCLA's Brain Research Institute.

The Institute said that deep electroencephalograms were made while monkeys and other animals were subjected to acceleration and vibrational effects during centrifuge and shaker apparatus experiments. The recordings, made with a special transistorized unit designed for satellite bio-packs, showed erratic electric discharges from the temporal lobe area of the brain characteristic of epilepsy.

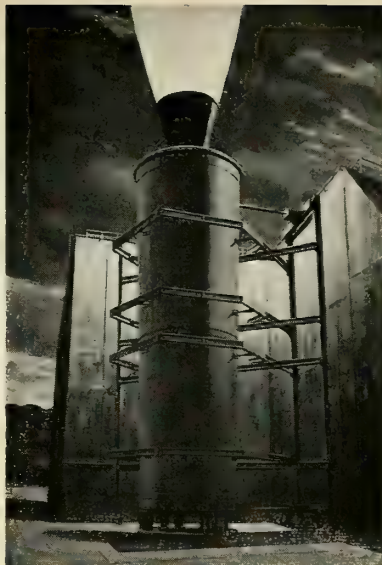
Dr. Ross Adey said this suggested that extreme vibrations drive the normal rhythms of the brain to abnormal discharges. The effect probably is only temporary, but it could prove critical in an astronaut's performance in space.

## New NASA Info Post

NASA has appointed Dr. Hiden T. Cox assistant administrator for public affairs.

Cox, currently director of the American Institute of Biological Sciences (AIBS), will assume his new position on December 1, 1961. Reportedly, the appointment is a temporary one.

The new office in NASA stems from Administrator James E. Webb's belief that NASA must improve its communications with the American public and Congress. Cox will be responsible for directing and coordinating policies and activities concerning dissemination of information, educational programs, and relations with other governmental agencies, universities, and industrial research.



## Department Head— Aerothermodynamics

This new position is currently available in our Engineering Sciences activity. We are seeking an outstanding scientist who has the stature and maturity to provide technical leadership for a small group of highly qualified aerothermo specialists performing studies concerned with advanced rocket propulsion systems.

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**despite reassurances . . .**

# Kennedy War Deterrent Remain

**Analysis shows U.S. is passing up opportunity to seize offensive—if downward estimate of Red ICBM power is correct**

THE KENNEDY Administration is staking the nation's security on a strategy of marginal deterrence despite claims this week of overwhelming nuclear power.

Moreover, for the fourth time since the end of World War II, an administration is declining—at least to date—to seize an apparent opportunity to build or employ strategic military might for taking the offensive in the Cold War.

It is against these hard truths that the widely publicized new explanation of Administration defense policies by Deputy Defense Secretary Roswell L. Gilpatric must be measured.

Gilpatric's words also must be measured against the background of three new and hardly calming Soviet military developments within the week:

—The detonation in the Arctic on Oct. 23 of a huge nuclear bomb with a force of more than 30 megatons and the previous Soviet announcement that Russia has in its possession a 100-megaton bomb. Two hours after the first blast, the Russians detonated a low-yield nuclear bomb underwater in the Arctic, probably testing an anti-Polaris sub weapon. On Oct. 25 they detonated another multimegaton bomb in the Arctic, bringing the total number of tests in the current series to 24.

—The launching on Oct. 23 into the Central Pacific of the seventh multi-stage missile in the current Soviet test series involving 7500-mile flights of new big boosters.

—The boast by Soviet Defense Minister Rodion Malinovsky, also on Oct. 23, that Russia has solved "the task of destroying missiles in flight." At the very least, Marshal Malinovsky's statement added considerable weight to Army intelligence reports that Russia is working hard on the development of an antimissile missile system.

• **Party line**—The importance of Gilpatric's policy explanation presented in an address Oct. 21 before the Business Council at Hot Springs, Va., is beyond question. It was reliably reported to have been approved in advance by President John F. Kennedy and Secretary of State Dean Rusk as well as Defense Secretary Robert McNamara.

Accordingly, Gilpatric's address is nothing less than the Administration's "party line" on defense matters.

Gilpatric's principal theme was that the Administration by building up the nation's limited war forces is increasing the flexibility with which the President can respond to Soviet moves in the Cold War. At the same time, Gilpatric sought to assure America and the world

## DOD Nuclear Claim: 'Tens of Thousands'



*Here is the text of Deputy Defense Secretary Gilpatric's Oct. 21 "explanation" of U.S. defense policy. Calming statement reportedly was personally okayed by President Kennedy.*

IT HAS BEEN my observation that the only way to keep the Government's defense policy clear in the minds of those not in Government is by constant reiteration.

Inevitably, in the course of public discussion, misinterpretations and misunderstandings of defense policy develop. It may be because we in Govern-

ment fail to make ourselves clear in the first place. Perhaps we take it too much for granted that having once stated a policy we have fulfilled our task of achieving public understanding. Or perhaps the subject is so complex that it requires a continuing dialogue between the Government and the people.

Whatever the reason, I am convinced that we have not yet succeeded in getting across to the public at large a full understanding of the defense policies we are now pursuing. Even for such well informed individuals as yourselves, it could be worthwhile for me to restate our defense objectives and what we are doing to achieve them.

Twice in this century we have gone unprepared into global conflicts and then waited until the war potential of

our economy could be called upon to see us through. Today, now that nuclear destruction has become possible, we can no longer place such reliance upon long-range potential and second chances. We therefore plan to obligate in this current fiscal year, about \$1 billion for military readiness and defense, the largest security expenditures for any peacetime year in history.

This figure is an increase of \$6 billion above a year ago, and \$9 billion higher than the year before that. Actual expenditures, which will rise to about \$47 billion this year, can be expected to climb still higher in subsequent years unless we achieve significant reductions in the world's international tensions.

*(Continued on page 36)*



# marginal

by James Baar

*Combat Atlas E raised from  
new Forbes AFB semi-hard launcher*



at the United States was in no way weakening its clear deterrent power.

It was in giving this assurance that many considered Gilpatric's address most revealing—and most comforting. However, few noted that some of the principal components of the proffered balm were half-truths.

"The fact is that this nation has a nuclear retaliatory force of such lethal power that an enemy move which brought it into play would be an act of self-destruction on its part," Gilpatric said, leading into the heart of his address.

"The U.S. has today hundreds of manned bombers capable of reaching the Soviet Union, including 600 heavy bombers and many more medium bombers equally capable of intercontinental operations. . . . The U.S. also has 45 *Polaris* submarines at sea carrying a total of 96 missiles and dozens of intercontinental ballistic missiles. Our carrier strike forces and land-based theater forces could deliver additional numbers of megatons. The total number of our nuclear delivery vehicles, tactical as well as strategic is in the tens of thousands; and of, course, we have more than one warhead for each vehicle."

Then Gilpatric added:

"Our forces are so deployed and protected that a sneak attack could not effectively disarm us. The destruction power which the United States could bring to bear even after a Soviet surprise attack upon our forces would be as great as—perhaps greater than—the total undamaged force which the enemy can threaten to launch against the United States in a first strike."

• **Dissection**—The overall effect of the Deputy Secretary's words is certainly one of reassurance to the casually informed American voter and the even more casually informed camel drivers of the world. But, when closely examined, the claims are found to be far less impressive and considerably misleading.

Gilpatric's listing of strategic deterrent power included "our carrier strike forces and land-based theater forces." The land-based theater forces comprise the *Thor* and *Jupiter* ICBM's deployed in Europe as well as *Matadors* and *Maces*, fighter bombers and the bulk of the medium-range bombers deployed around the Soviet Empire's periphery. Unfortunately, the Russians have long been credited with a sufficient stockpile of ICBM's and MRBM's to wipe this entire force from the board on a first strike.

As for the attack carriers, there are five deployed in advance positions from which a retaliatory blow of a relatively small number of bombers could be mounted. However, whether the carriers in advanced positions would survive the initial attack is debatable.

Gilpatric spoke of "tens of thousands of nuclear delivery vehicles, tactical as well as strategic." Such a number has little to do with strategic deterrent force. Well over 90 percent of a total of this size is made up of short-range tactical weapons.

Gilpatric spoke of "six *Polaris* submarines at sea carrying a total of 96 missiles." However, only five *Polaris* submarines carrying a total of 80 missiles have been deployed to date. And, of these, one or more is undergoing resupply and refurbishing at Holy Loch, Scotland.

Gilpatric spoke of "dozens of intercontinental ballistic missiles." The United States today has 45 operational *Atlas* ICBM's deployed in soft and semi-soft launchers at bases in five states. Only a part of this force is ready to fire within 15 minutes at any one time.

Gilpatric spoke of "600 heavy bombers and many more medium bombers equally capable of intercontinental operations." Actually there are about 570 B-52 intercontinental jet bombers and only several hundred medium bombers based in the Western Hemisphere.

Therefore, despite Gilpatric's "tens of thousands of nuclear delivery vehicles," U.S. deterrent power outside the range of Soviet ICBM's and MRBM's is comprised mainly of the SAC B-52 bomber fleet, several hundred medium bombers and a total of less than 100 *Polaris* and *Atlases* "in the green."

The destruction of this force would not take an enormous number of Soviet ICBM's and submarine-launched missiles. Less than about 400 Soviet missiles capable of reaching the United States would be more than enough to disable everything except for those bombers able to get off the ground in time, the small bomber force on airborne alert and the three or four *Polaris* submarines on station. The surviving bomber force then would suffer further losses running the formidable Soviet air defenses.

As late as the first months of this year, some U.S. intelligence estimates forecast that the Russians would have 300 or more ICBM's by January, 1962, and possibly 1000 by January, 1963. Soviet ICBM production

(Continued on page 40)

From own staff . . .

# NASA Discloses New Apollo Bosses

**Golevin, Lowe, Roadman  
and Rosen to head major  
groups; program office line-  
ups are amplified**

NASA's super-management office for the *Apollo* program will lean heavily on current space agency personnel to fill its top positions.

Only one top job in the Office of Manned Space Flight—that of deputy to Director B. Brainerd Holmes—remains to be filled. It is considered likely that an industry official will be tapped for the position.

Directors of all of the four major management groups within the office, however, will be filled by NASA officials including:

—Dr. Nicholas Golovin, currently chairman of the joint NASA-DOD committee which is considering future U.S. space programs will serve as director of systems engineering for all spacecraft and launch vehicles in the *Apollo* program.

—George M. Lowe, currently head of the Manned Space Flight Office at NASA headquarters, will be director of Manned Spacecraft and Flight Missions, primarily concerned with development of the *Apollo* spacecraft and advanced *Mercury* spacecraft for advanced manned earth-orbiting missions.

—Gen. Charles H. Roadman, an Air Force officer assigned to NASA, will serve as director of the Office of Aerospace Medicine.

—Milton R. Rosen, now assistant director of launch vehicle programs, will serve as director for Launch Vehicles and Propulsion, responsible for development of the *Saturn* and *Nova* class vehicles which will be used in the lunar program.

• **Four firm offices**—The *Apollo* management was disclosed as the space agency released further details of its reorganization into four program offices. NASA expects to hire approximately 300 more people for the moon office, but these will be primarily in lower positions. While Holmes will probably refine the management setup for the Office of Manned Space Flight, the organization of the other offices is firm.

A breakdown:

• The Office of Space Sciences will be responsible for all unmanned exploration of space, the moon and the planets. Its director will be Dr. Homer Newell. His deputy will be Edward Cortwright, currently head of NASA's Lunar and Interplanetary program. It will have a launch vehicle and operations group headed by Air Force Col. Don Heaton which will be responsible for development of the *Centaur*, *Agna*, *Delta* and *Scout* launch vehicles. Other groups within the office include Grants and Research Contracts, headed by Dr. Tom Smull; Geophysics and Astronomy, position vacant; Lunar and Interplanetary programs, Oran W. Nicks; Bio Science programs, probably Dale Smith.

All of the latter are current NASA personnel.

• Office of Applications will be responsible for the communication satellite and weather satellite programs. NASA director has been named. John Burk, a Siegler Corp. executive, was offered the job but has declined. Three other industry officials are being considered.

The rest of the major positions in the office—with one exception—will be filled by current NASA personnel including Mort Stohler as Deputy Director, Dr. Morris T. Pepper as director of Meteorological programs, and Leonard Jaffe as director of communication satellite programs. A Director of Future Applications—to be responsible for finding ways of getting the results of NASA R&D into the market place—has not yet been selected.

• The Office of Advanced Research and Technology will control the Rover nuclear energy programs, *Snape*, and the development of all other advanced research programs. Its director will be Dr. Ira Abbott. A deputy has not been appointed, but he will come from NASA.

The rest of the Office's breakdown includes: Director of Nuclear Energy, Harold Finger; Director of Aeronautical Research, John Stack, currently assistant director of the Langley Research Center; Director of Research in the fields of Chemistry, Physics, etc., Dr. H. H. Kurzweg; Director of Electronics and Control, Dr. Al Kelly. The positions—Director of Propulsion and Power Generation and Director of Space Vehicles—have not been filled.

• **One switch**—When NASA announced preliminary details of its reorganization last October, the Space Agency said that Thomas F. Dixon, deputy to Associate Administrator Robert C. Seamans, Jr., would direct a small management group to run the development of all small launch vehicles.

Instead, that program has been placed under the Office of Space Sciences.

NASA officials report, however, that Dixon will continue to keep a close eye on the small vehicle development, principally because of the eight-month slippage in development of the *Centaur* vehicle.

Technical difficulties with the *Centaur* engine have forced NASA to drastically reduce the size of the *Mars* spacecraft which will be launched next year with a *Centaur*.

It has also raised the possibility that the *Advent* communication satellite may have to be launched with another vehicle or delayed. Approximately 10 *Centaur* development flights are scheduled next year, with the first slated for early in January.



# NASA Buying Huge Test Facility

**Mississippi setup for static-firing  
big boosters may cost \$400 million eventually**

by Hal Taylor

NASA WILL SPEND over \$200 million for a massive static test-firing facility for large space boosters which will be located in Southwest Mississippi. Space agency officials said that the cost of the facility—which is expected to be completed in about three years—will ultimately total \$400 million.

The facility—on which at least six test stands for *Nova* and *Saturn* boosters will be built—will be 400 sq. miles in area, twice the size of the recent expansion of Cape Canaveral.

This will include 13,500 acres of land on which the facility will be built. In addition, 128,000 acres including 100,000 acres in Pearl River and Hancock Counties in Mississippi and 25,000 acres in St. Tammany Parish in Louisiana will be acquired as a buffer zone to absorb the noise created by the firings.

Land acquisition costs will total \$15 million. The cost of blockhouses, test stands, support buildings and equipment will run the cost initially to at least \$100 million. Later expansion is expected to push the figure much higher. NASA said at least six test sites will be built with two stands on each. The first ones to be built will be used to test the follow-on version of the *Saturn* booster which will probably be the C-4, developing 6 million lbs. thrust. Other boosters will be built eventually for the *Saturn* superbooster, which will develop 10 million lbs. thrust. It is also likely that large upper stages of the *Saturn* and *Nova* boosters will be test-fired at the facility.

NASA is also considering building a "multiple-use" test stand which could be used to test-fire several different types of boosters.

It is also probable that the site will be used for the test firing of large solid-fueled boosters as well as liquid-fueled boosters.

The Pearl River Area was one of the areas considered for the facility in the Gulf Coast area. It is only 35 miles from the Michoud, La., plant where the *Saturn* class of launch vehicles will be built. There is also the possibility that the *Nova* vehicle will also be built there.

The alternative is a new plant in the same general area.

The static test-firing facility will employ 500 to 1000 scientists and engineers who will be under the direct supervision of the Marshall Space Flight Center in Huntsville, Ala.

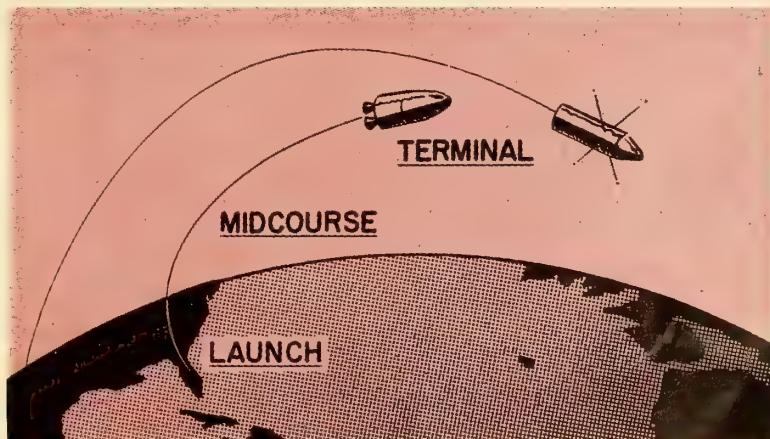
One of the prime criteria in the site selection was access to deep water. The Pearl River area will supply water-borne booster transport to the Michoud plant via the Pearl River and Intercoastal Waterway.

Space agency officials said construction

will begin next spring.

The officials said that the ultimate size of the facility and the types of test stands that will be built will depend upon further developments in the U.S. manned space flight programs.

Part of the decisions will hinge on the report of a joint NASA-DOD committee now considering the best methods, launch vehicles and spacecraft for the U.S. Space Program. As a result, firm decisions on the types of test stands will not be made until after the first of the year. ❧



## Rendezvous Recommendation Imminent

A TOP-LEVEL DOD-NASA committee will shortly recommend that the U.S. pursue the "space rendezvous" concept as a chief means of achieving a manned lunar landing.

The group's report to President Kennedy on the long-term goals and needs of the U.S. space program was scheduled to be completed last week, but will be delayed until sometime in November (M/R, Oct. 9, p. 16).

It has also been learned that the committee will probably also recommend that NASA build the *Saturn* C-4 with four F-1 engines as the next large super-

booster.

The committee and the Marshall Space Flight Center estimate that the C-4 will take from three to six months longer to develop than the earlier concept of a *Saturn* C-3 with two F-1 engines. Other NASA officials contend, however, that it could delay development as much as 1½ years.

All of the vehicles would be used for "rendezvous," calling for mating craft in space orbit for long flights to the moon. One NASA concept (see picture above) involves mating the vehicles while in earth orbit. ❧

# Liquid Bullpup Motors in Production

BRISTOL, PA.—Packaged liquid engines for the Navy's *Bullpup* air-to-ground missiles are rolling off Thiokol Chemical Corp. production lines under a \$4-million initial production contract.

The engine, designated LR58, is extremely simple in design with only one moving part. Thiokol engineers say it is capable of scale-up to virtually any size.

Production equipment and machine tools are standard. The entire line is geared for a station-to-station transfer time of 20 minutes. The major emphasis is on quality control.

In one instance, sections of the LR58 headed for welding operations must have been thoroughly cleaned no more than four hours before. Zyglo and X-ray facilities are an integral part of the line.

• **Component parts**—The oxidizer, inhibited red fuming nitric acid, and a mixture of amines are stored in an aluminum tank shell. A solid-propellant charge furnishes the pressurization medium and an initiator complete the missile.

A combination injector and initiating mechanism is the only moving part. Initiation is caused by shearing a set of cups separating the hypergolic propellant elements. The cups themselves are set in carefully machined injection ports which regulate the liquid flows.



RING OF shear cups in the initiator and mixing section of the liquid Bullpup engine passes rigid inspections.

Thiokol's production facility includes loading—so that the engines leave ready for operational use.

The prepackaged engines have all the handling characteristics of a solid-fueled unit. The propellants are inert until mixed. Drop tests from as high as 40 ft. have been performed. Extreme temperature or atmospheric conditions have no effect on performance.

Thrust termination devices can be included and higher energy propellants used without significant design or production changes. Martin Co., prime contractor for the *Bullpup* system, credits the liquid engine with greater re-

liability, versatility and range than the currently operational solid *Bullpup*.

The *Bullpup* is radio-controlled by the pilot of the launching aircraft. Thiokol's liquid engine is essentially smokeless, making the weapon difficult for an enemy to spot. Two tracking flares installed in the aft fairing aid the pilot in guiding the missile to its target.

• **New control system**—A nuclear *Bullpup* (GAM 83B) is under development by the Air Force. Because of blast effect, an offset launch system has been perfected. This will permit the pilot to guide a nuclear *Bullpup* to a target from an offset position instead of following the weapon towards its target in a dive.

Value analysis programs at Martin have reduced the cost of production *Bullpups* well over 50%. The weapon costs less than any other comparable missile to destroy a majority of tactical targets.

Engines for *Bullpup* "B", a larger more advanced version, are in development at Thiokol's Reaction Motors Division under a \$1.033-million contract.

Development and PFRT of the LR62 (*Bullpup* "B" engine) has been completed and the engine is now undergoing MIL Spec qualification testing. Ballpark range figures for the "B" missile are 9 to 10 miles.

## Electronic System Improves Navy Solids

INDIAN HEAD, Md.—A unique electronic combination of an automatic data acquisition system and computer complex (ADACC) has enabled the Naval Propellant Plant here to substantially increase the production of solid propellants for *Polaris* and other Navy missiles.

Revealed for the first time last week, the system consists of an RCA 501 computer and an Interstate Electronics Corp. data-gathering unit which made it possible to instantaneously calculate propellant and motor performance.

The ADACC system—the only one of its kind, according to the Navy—accepts information directly from a rocket motor in the firing bay while at the same time performing the analysis of the rocket motor's firing characteristics.

Supplementing ADACC, the propellant plant has been equipped with an

automatic data recording system to collect data from the firings of small charges of solid fuels. This information is fed into the 501 computer and in less than a minute evaluation of the fuel's performance is finished—a task that formerly took 40 to 80 man-hours.

In addition to providing almost instantaneous information to the firing officer during the test, the ADACC system performs follow-up calculations that would take weeks by other means. This capability, according to the Navy, enables changes to be made in the fuel mixtures which in turn improve the motors or propellants before they come off the production lines.

During a firing, the computer checks the motor's pressure, temperature and thrust every .006 seconds. If the system receives signals denoting unusual conditions, it sends warning signals to the

firing officer through the data-gathering system. However, if a critical point is reached, the computer is programmed to automatically shut the test down.

In addition to processing propellant and motor tests, the 501 computer is used to calculate missile trajectory data, heat transfer, burning rates and other complex problems. However, when firing test is scheduled, the computer interrupts any other problem that it has been working on and stores the information on magnetic tape.

After it has checked out the firing equipment and processed the data from the firing test, the computer automatically returns to the stored problem.

With the addition of ADACC, Capt. Otis Wesche, commanding officer of the plant, stressed that the Navy's potential for improving solid-propellant motors has been greatly enhanced.



# DOD In-House Labs Win 'Primary' Role

IN-HOUSE DOD laboratories are being up-graded to a "primary" role in carrying out new weapons development.

The question seems to be, how primary is "primary"? Or if it is largely a morale gimmick.

The new measure of responsibility, ordered by Defense Secretary McNamara in an Oct. 14 memorandum, conceivably could bring about some head-on collisions with "non-profit" and industrial laboratories and organizations presently overseeing the management of many weapons programs—if the labs grab the initiative.

In any event, there seems to be little doubt that the lines of authority for the "non-profits" must be re-drawn somewhat to permit the in-house labs to take over a greater management role. This was made clear last week by Harold Brown, director of defense research and engineering, who summed up the problem in a Naval Research Laboratory talk:

"These non-profit laboratories are a tremendous asset . . . But—and let us be candid among ourselves as well as with the non-profit groups—they must operate within clearly defined systems of constraints. We must find a more effective way for the Defense scientists and engineers to participate more actively in directing the effort of the non-profit groups as well as the work of the industrial laboratories.

"This implies that we recognize a large responsibility for the Defense Laboratories—even larger for the *existence* of the non-profit laboratories."

The Air Force in a recent policy statement said it wants to preserve the "elite nature" of its five non-profit technical advisory corporations. But it conceded precautions are needed to guard against conflict of interest and in holding the salary line.

• **McNamara's "principles"**—In ordering Brown to strengthen the in-house labs, McNamara told him to observe these "principles":

— "The in-house laboratories shall be used as a primary means of carrying out Defense Department programs. They shall provide scientific and technical advice in the exercise of Government responsibility for development and acquisition of new weapons.

— "Clear lines of technical management and responsibility shall be established for each in-house laboratory. To

this end, the policies and practices on rotation of duty for officer-scientists will be such as to permit extended tours of duty in positions for which they have demonstrated technical proficiency. In addition, procedures will be established by which the principal laboratories of each service will be brought under the more effective control of the assistant secretaries for research and development of each of the military departments.

— "Depending upon the mission and nature of the work of the particular laboratory, a fraction of the annual laboratory budget shall be set aside for work judged by the laboratory director to be of promise or importance without need of prior approval or review at higher levels. The results of this work shall be reviewed by the assistant secretaries for research and development of the military departments.

— "Full and complete advantage shall be taken of the existing PL-313 provisions which set compensation rates for senior technical personnel in the Defense laboratories. This specifically includes recognition of outstanding performance by the working scientists and engineers

who are not in administrative positions.

— "Working with other interested Government agencies as appropriate, the Department of Defense will make every effort to secure rates of compensation for its senior personnel which, commensurate with the responsibilities which they exercise and with their professional talents, are consistent with levels set outside as well as inside the Government service."

• **Morale problem**—In his NRL talk, Brown made no bones about the fact that the McNamara memo was directed at curing a "bad" morale problem in in-house labs stemming primarily from poor management.

"In some of the best laboratories," said Brown, "the disillusionment with the Defense Department and the Military Service as managers is approaching the critical state."

The R&E chief said low pay scales (industry salaries may be more than double) for lab directors, lack of recognition of competence in lab personnel, and poor working facilities were contributing to the morale breakdown. Hence, strong medicine is needed, quickly. ✱



**X-15's Broken Window**

WINDSHIELD PANEL on X-15 cracked after AF Maj. Robert M. White had completed re-entry maneuver after 215,000-ft. flight Oct. 10. Cause is still being studied.

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# Technical Countdown

## ASTRONAUTICS

### Dissent Voiced over Exotic Lunar Rovers

Solutions to the problem of developing lunar-roving vehicles lie not so much in exotic types of locomotion as a rational adaptation of conventional vehicles to the environment. This was the conclusion of a paper on "Land Locomotion on the Surface of Planets" presented at the recent New York ARS meeting by M. G. Bekker of GM's Defense Systems Div. Giving the lie to the clamor about exotic lunar vehicles, Bekker asserts that locomotion on a planet will evolve from studies of that planet's physical properties and surface geometry.

## SUPPORT EQUIPMENT

### 'Aeropad' Proposed for Space Vehicle Transport

A variation of the water transport concept for large space vehicles has been proposed by Aerojet-General Corp. Called "Aeropad," the system is defined as an integrated transport and launch system for land operation which permits massive loads to be transported over low-soil-bearing land with a minimum of surface improvements. The Aeropad, according to the company, would be supported by fluid pressure from a pump source piped between the pad bottom and a prepared surface such as asphalt or concrete. Floating a little more than 2 inches above the prepared surface, the system would provide a lifting force of 1000 lbs./sq. ft. over the entire pad surface.

### Army Gets New Air Defense System

A helicopter-transportable air defense system for coordinating the fire of *Hawk* and *Nike* batteries, developed by Hughes Aircraft Co., is now in use by the Army. Installed in five or more plastic and aluminum shelters, the system consists of one operations central and four or more coder-decoder units. The system—designated AN/TSQ-38—enables a battalion commander to assign targets, monitor the air battle, and quickly determine operational status of his air-defense units.

### DRIFT Improves Re-entry Communications

DRIFT (Diversity Receiving Instrumentation for Telemetry), developed by Lockheed-California Co. for the *Polaris* program, is reported to have reduced the communications blackout experienced by re-entering vehicles from 20-30 seconds down to zero, in some cases, or at most 9 seconds. The company claims that by using microwave frequencies at about 5000 mc. in conjunction with a new parametric amplifier it has increased sensitivity of telemetry receivers to more than 100 times that of current equipment.

## PROPULSION

### EBW Introduced Into the Saturn System

Exploding bridgewire circuits are replacing the standard ordnance items used as initiators on the *Saturn* booster, missiles and rockets, October 30, 1961

according to one Marshall Space Flight Center official. Citing the relative insensitivity of EBW circuits to temperature and shock, he stressed the safety afforded to personnel due to the great amount of current required over a very short time period—of the order of 500 amperes over 1 microsecond—before EBW will operate.

## ADVANCED MATERIALS

### Ceramic Tooling & Titanium

Lockheed is taking another look at titanium—this time with ceramic forming tools in mind. The metal easily can be hot-formed with imbedded element ceramic dies. Glasrock Products, Inc., manufacturers of ceramic tooling materials, has been experimenting with Teflon-coated, self-heated ceramic dies for plastic applications.

### Ductile Tungsten Obtained

Westinghouse researchers have produced single crystals of tungsten 10 in. long and 0.2 in. wide with purities up to 99.9975%. The ultra-pure crystals are ductile—even at temperatures down to  $-330^{\circ}\text{F}$ . Specially designed electron-beam zone-melting equipment is used to produce the commercially available crystals.

### World's Largest Arc Heater for NASA

An arc heater capable of supplying a 10-minute stream of high-pressure air reaching temperatures of  $12,000^{\circ}\text{F}$  is being built for NASA's Langley Research Center, Va., by Westinghouse Electric. The heater and its d-c power supply will cost slightly more than \$1 million, W.E. says.

## ASW & SEABORNE SYSTEMS

### Antarctic Study Starts in January

Texas Instruments Inc. has just been selected to provide an operating and maintenance team to man the USNS *Eltanin*, Antarctic oceanographic research vessel. Funded by the National Science Foundation, the broad study program will begin in January. The effort will not only include marine and geological samplings for on-board analysis and underwater photographic studies, but will encompass meteorological and upper-atmosphere physical research. Total outlay to date, says the Foundation, is \$5.5 million.

## OPTICS

### Pershing Theodolites Delivered

First portable theodolites offering accuracies comparable to conventional fixed-site instruments are now being delivered for use with the Army's *Pershing* missile system. Built by Perkin-Elmer for The Martin Co., the units employ north-seeking gyros to establish and correct missile azimuth heading in the shortest possible time, developers say. Outputs are fed directly to a computer in the firing set for missile erection and launch.

# SPAR Heralds New Era

*Navy's million-dollar tube will be used for unmanned acoustic research; more stable than submarine, 350-ft. vessel will operate with 86% of its length submerged*

THE NAVY is planning to build and send to sea for acoustics research a \$1-million tube of scientific devices.

Called SPAR—for Seagoing Platform for Acoustic Research—the vessel is a companion piece to FLIP (Floating Instrument Platform) also being developed by the Navy (M/R, July 3, p. 37).

Both vessels presage a new look in oceanographic instrumentation—the first in many years. And the imagination used in devising such vessels means that more money is becoming available for a refined attack on the problems of understanding the ocean.

It also means that the Navy realizes that only through basic oceanographic research can it hope to get a lead on the nuclear-submarine detection problem.

• **More money**—The current program level of \$97.5 million for oceanography is an increase of \$44.5 million or about 81% over fiscal year 1961 (M/R, Aug. 28, p. 22).

This build-up is part of the national effort in oceanography proclaimed by President Kennedy in his inaugural speech and detailed in his message to Congress on March 29.

The Navy's contribution to the national oceanographic program is \$32 million for the present fiscal year; its total budget including military oceanography is \$54 million plus a supplemental add-on.

• **Stable platform needed**—The Naval Ordnance Laboratory is developing SPAR as a stable platform for mounting oceanographic instruments, chiefly those useful for sonar and acoustic work. Designed to survive in the rough seas of the Atlantic, the vessel will operate tended but unmanned, whereas FLIP will be manned and deployed in calmer waters of the Pacific.

Chief reason for designing SPAR was to get a highly stable ocean plat-

form. Specifications limit the vessel's vertical velocity to less than one fps.

Such stability is needed in order to cut down the noise around a vessel's hydrophones—noise usually brought in by water slap and vibrations that accompany even the quietest craft.

To gain this high stability, SPAR will—like an iceberg—have most of its volume underwater. The vessel will be 350 ft. long, only 50 ft. of which will be above the water line when the craft is operating; diameter will be 16 ft.

It will have 500 tons of steel in its structure and its displacement will be equal to that of a World War II submarine. In fact, an early idea was to make a stable platform out of a sub by flooding one end until the vessel turned vertical. The venture was soon discarded as being too costly.

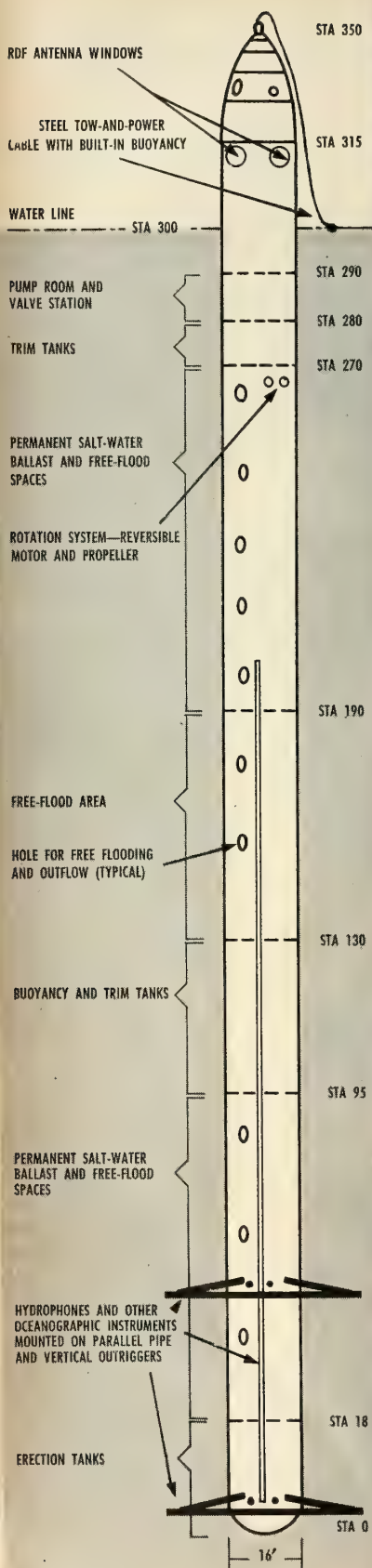
SPAR is towed in a horizontal position by a tender at a maximum speed of six knots to its ocean site. Here, the research vessel's compartments are flooded until the craft swings into a vertical position. A 2000-ft.-long umbilical cord carries control data and power to SPAR during its research operations.

SPAR is turned on its longitudinal axis by a submerged propeller until the vessel's hydrophones are pointing at a participating research ship that may be 50 to 75 miles off. Then, by an interchange of acoustic and electromagnetic signals between SPAR and the research ship, scientists get data on how acoustic energy travels through water; and on the effects of temperature, pressure and salinity on the sound vectors.

When SPAR's work is done, compressed air forces water out of a tank at the vessel's lowermost end, thereby giving the tube the initial turning moment needed to begin an outflow from the upper free-flood tanks.

• **It's very quiet**—According to engineering plans drawn for NOL, the

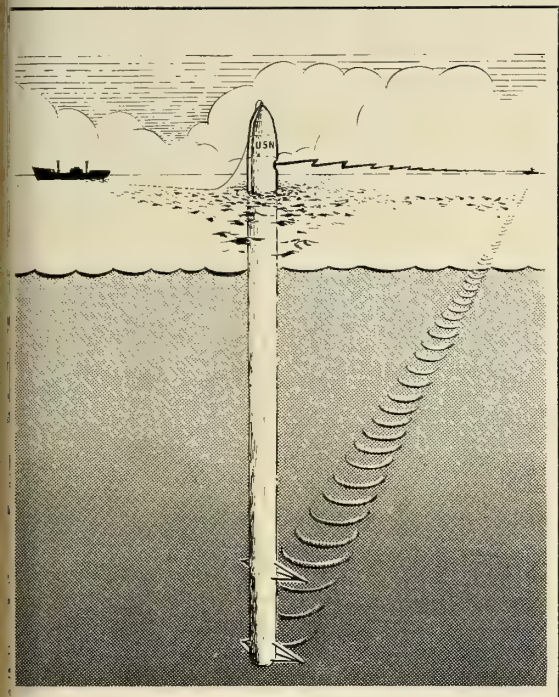
missiles and rockets, October 30, 1961



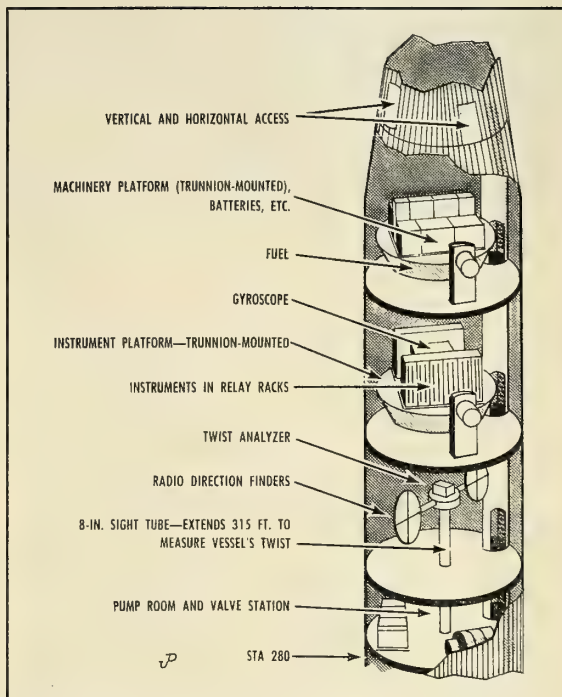


# Oceanographic Instrumentation

by William Beller



SONAR AND ELECTROMAGNETIC signals from research ship form part of SPAR's data collection. Tender is seen at left.



SPAR'S UPPER 70 FEET are given over to instruments and machinery, some of which are kept vertical by trunnion mounts.

Upper 70 ft. of SPAR is given over to radio direction-finding antennas, trunnion-mounted panels, trunnion-mounted machinery platform and fuel storage, and a pump room and valve station. Men can crawl into access panels on SPAR's nose to service the vessel even when it is in a vertical position.

Two outriggers near the vessel's bottom and an exterior pipe running long about half the vessel's length are used for mounting hydrophones and other scientific equipment. Although the instruments are subject to some wave slap and eddies, the noise is far smaller than oceanographers are accustomed to hearing through their hydrophones.

Contract plans for SPAR's design were prepared under the technical direction of NOL's Air and Surface Mechanical Engineering department by M.

Rosenblatt and Sons, Inc., naval architects and marine engineers of New York. The San Francisco branch of this firm drew up the plans for FLIP.

The big difference between these two projects is that SPAR is unmanned. As a result, all research on the vessel has to be done by remote control or automatically, which just about doubles the cost compared with the manned version.

When larger SPARS are made, thereby rendering them habitable in the Atlantic seas, some of the automation can be removed. Project engineers estimate that after the go-ahead it would take five to six months to build the present SPAR configuration. Right now, the project is under design review by the Bureau of Ships.

The Marine Physical Laboratory of Scripps Institution of Oceanography and

NOL started last year to devise stable oceanographic platforms; more or less independently, they arrived at similar solutions.

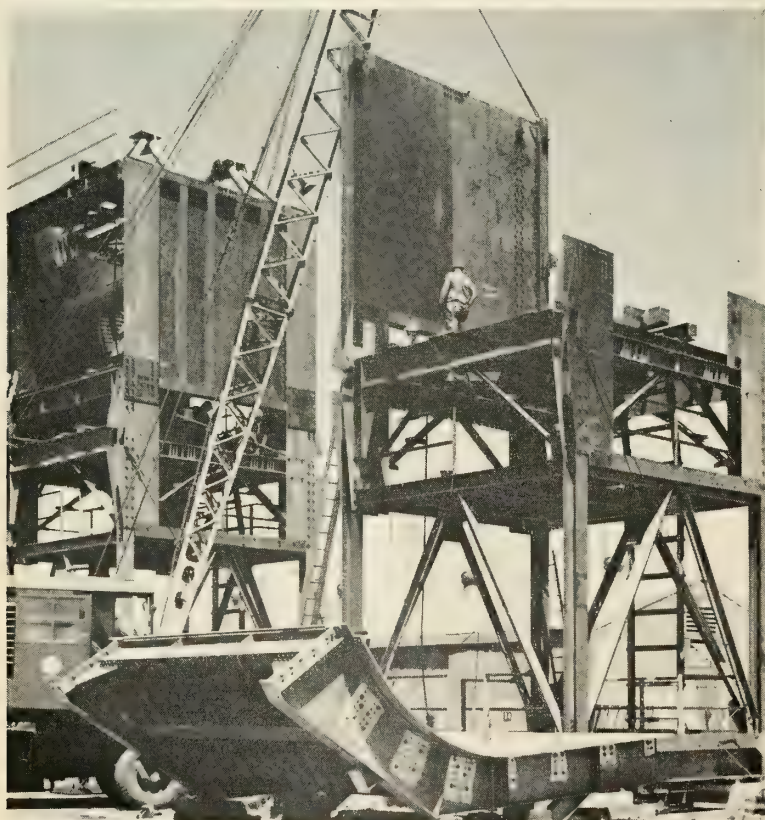
MPL's first thought—after the Navy discarded the submarine idea—was to lower a telescoped instrument tube from a barge to a great depth; or swing a long hinged-truss from the barge into the sea. Unhappily, barges do not have the needed stability.

NOL also considered using combinations of barges, floats and trusses—but again the need for high stability ruled the designs out.

FLIP, which is a modified tube 165 ft. long, will be used for a wide variety of oceanographic work, including biological sampling. On the other hand, SPAR is designed for the vital Navy function of gathering data for basic acoustic research. ❖

## Atlas F's Getting Huge Platforms

**Seventy-five-ton launch structures will have tolerances as close as  $\frac{1}{8}$  in., double as elevators for missiles at hardened Atlas sites in six scattered SAC installations**



**A HUGE STEEL PLATE**—part of the blast deflector for the 75-ton Atlas F launcher platform—is shown being gently lowered into place. Being built to extremely close tolerances, the platform will be installed at six hardened missile bases in the Midwest, Southwest and Eastern U.S.

LAUNCHER platforms weigh in close to 75 tons each and assemble with horizontal tolerances of  $\frac{1}{16}$  in. They are being fabricated for six *Atlas* hardened sites.

Approximately 45 ft. high, the platforms are fabricated from steel structures that are test-erected at U.S. Steel Consolidated Western Steel Division plant at Maywood, Calif., before being dismantled and shipped to the *Atlas* sites. This is to insure that the extremely close tolerances— $\frac{1}{8}$  in. from the top of the footings to the bottom of the structure's base plates as well as the horizontal limit—have been achieved.

• **Structure's dual role**—In addition to being a launch platform for the *Atlas*, the structure serves as an elevator to lower the missile into the silo for vertical storage. And when the missile is ready for firing, it raises it until the blast deflector on the platform clears the mouth of the silo.

At the top of the four-level launcher platform are two tripods which mount four steel pads to support the missile. Immediately below the heavy-walled tripods is the blast deflector—fabricated from 1-in. USS "T-1" steel. The T-1 steel was chosen, according to Western officials, because of its exceptional resistance to the flame and blast effects of a missile launch.

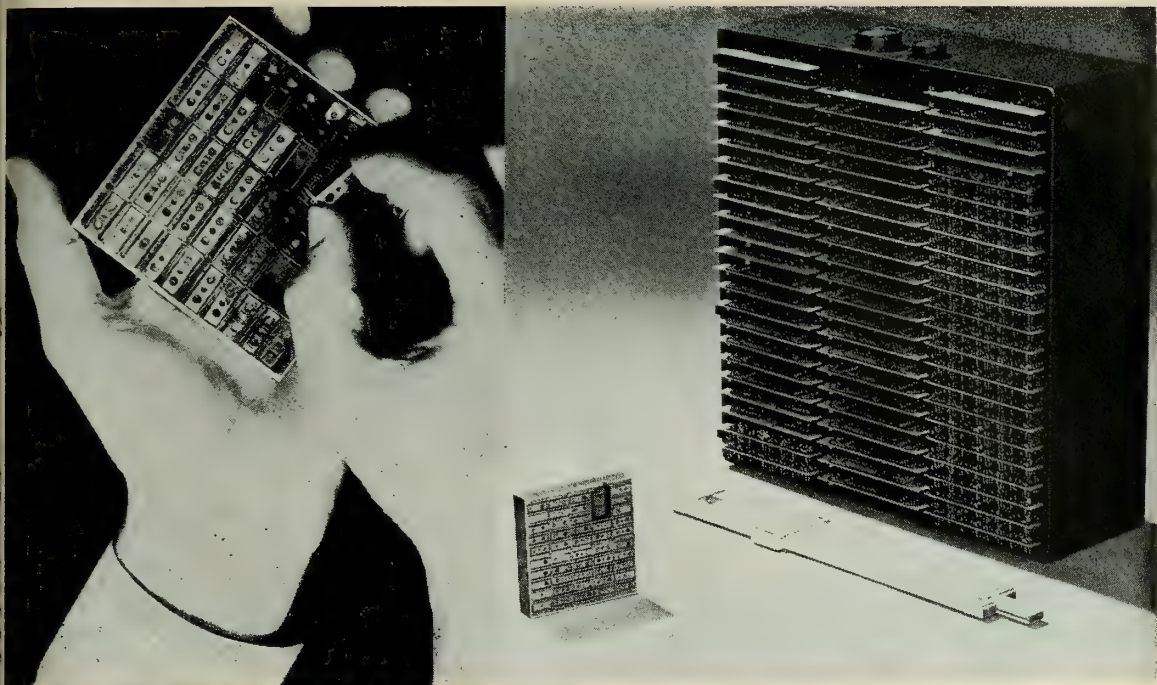
Consolidated Western is also building maintenance platforms, a ventilation system and other handling and servicing equipment for the underground sites.

The launcher platforms—designed by American Machine & Foundry Co. from Consolidated Western's detailed drawings—are being built under contract to the Astronautics Div. of General Dynamics.

After the platforms have been fabricated and test-erected, they will be shipped to the *Atlas* "F" sites at Schilling AFB, Kan.; Lincoln AFB, Neb.; Altus AFB, Okla.; Dyess AFB, Tex.; Walker AFB, N.M., and Plattsburg AFB, N.Y.

missiles and rockets, October 30, 196





**MICROMINIATURIZED DIGITAL** computer composed of 587 separate Solid Circuit wafers performs same functions as conventional transistorized unit (right) which is 48 times heavier

and 150 times larger. Ten-ounce unit (center and left), using 47 modules plugged into a computer matrix, was developed by Texas Instruments Inc. for the Air Force.

## electronics

# Solid-State Circuitry Computer Shown

**Texas Instruments builds 10-oz. digital unit which matches functions of device 150 times its volume**

by Charles D. LaFond

DAYTON, OHIO—A way of using completely microminiaturized solid-state circuitry in a practical system was demonstrated for the first time last week.

With tiny silicon-wafer digital networks connected and encapsulated to form rigid modules, engineers built a 10-ounce digital computer which can perform all the functions of a conventional transistorized computer 48 times heavier in weight and 150 times larger in volume.

Culminating two years of research in the development of microelectronic circuits, Texas Instruments Incorporated also announced the commercial avail-

ability of a whole series of Solid-Circuit semiconductor networks. Known as the Series 51 line, the new components include six different digital circuit modules.

Ninety percent of all digital equipment circuit functions can be handled by these six devices, according to TI President P. E. Haggerty.

Employed in the experimental computer which was demonstrated, the semiconductor networks accounted for 95% of the total circuitry. The whole unit occupies only 6.3 cu. in.

The computer was built for the Air Force to forcefully demonstrate the results to date of this part of its Molecular Electronic Program. It was developed, assembled, and successfully tested by TI in 9 months, an AF spokesman said.

• **Solid Circuit networks**—Each network in the TI Series 51 is contained in a hermetically sealed outer case measuring  $\frac{1}{4} \times \frac{1}{8} \times \frac{1}{32}$  in., excluding leads. Total volume of each is about 0.001 cu. in. A comparable circuit using conventional semiconductors and other

components would require nearly 1 cu. in. total volume.

The first solid circuit developed by TI was shown to the Air Force in October, 1958, and revealed publicly at the 1959 Annual Institute of Radio Engineers Conference in New York City. Early in 1960, units were made available for industry evaluation in sample lots.

The Series 51 line now obtainable in quantity is an improved version of the earlier networks, TI says, with advances made in circuit design, miniaturization, and fabrication techniques.

Relatively few process steps are now necessary in production of the devices. This permits a high degree of control and further enhances reliability, TI says. All units in the series are built up from a very-pure standard silicon wafer. Electrical paths are cut in the slices or wafers; then appropriate connections are made to create six different circuit functions.

Circuits are protected with an oxide coating and the leads for point-to-point



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**Mobile**—AMF designed and built AN/TPQ-10 precision tracking antenna that demounts into shock-resistant, immersible components. AN/MPS-4 and 16 are AMF-designed trailer and truck-mounted types.

**Stabilized base**—Design and fabrication of SX, AN/SFS-8B High Gain Antenna, AN/SPS-3 Dual Foster Scanner.

**Precision pedestals, theodolites**—AMF's Precision Instrument Mount controlled by optical digital discs accurate to 0.05 milliradians. It tracks missiles and satellites.

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connections on the silicon bar are vapor-deposited.

The new devices consist of

—A flip-flop/counter circuit (SN 510).

—A flip-flop/counter circuit with emitter follower output (SN 511).

—A NOR/NAND gate (SN 512).

—A NOR/NAND gate with emitter follower output (SN 513).

—Two NOR/NAND gates in a single package (SN 514).

—An exclusive OR gate (SN 515).

Designed for operation in a temperature range from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , the units have a power drain of from 2 to 4 milliwatts at 3 volts. Supply voltage requirements are from 3 to 6 v. Propagation delay is from 75 to 450 nanoseconds.

Unit prices, Haggerty says, will range from \$95-115. Thousand-unit lots will be priced at rates down to \$50-65 per unit. Quantity prices, he said, make the units competitive with semiconductor-type circuit boards providing equivalent functions—when labor costs are considered in system applications.

He predicted that costs will be directly competitive with military-quality circuit boards by 1963, with industrial types by 1966-67, and with consumer quality items in 10-12 years.

Carrying his forecasts even further, Haggerty told M/R that he believes over half of TI's semiconductor component revenues will be derived from Solid Circuit sales in 10 years. He does not, however, believe that the new field will cut into conventional semiconductor sales by 50%; rather, he sees it finding new applications and growing with its associated industry.

The company said that although units are now available, tests will be continued to determine high-temperature storage and operating-life limits. Additional ambient temperature and other environmental tests also are being conducted as part of TI's continuing reliability studies.

• **Minified computer**—A multitude of the tiny Solid Circuits have been used by TI to build its new digital computer. The complete package is made up of 47 modules. Each module contains from 8-16 of the thin semiconductor networks.

Individual networks perform the function of from 10-29 conventional miniature or solid-state components. Each module performs the work of some 150 individual components.

The complete unit, according to TI, is composed of 587 separate Solid Circuits—equivalent to roughly 8500 conventional components.

The 47 modules employed are plugged into a computer matrix. Each module contains an average of 12 net-

works, occupies roughly 0.057 cu. in. and weighs about 0.04 oz.

The finished package is a serial, binary, fixed-point computer having an operand word length of 10 bits, plus sign. Using synchronous logic, the system is timed from an internal 100-kc clock.

Memory is divided into two parts, operand and instruction. The complete unit is actually a general-purpose computer.

Three types of Solid Circuits were used in the design of the system: RS flip-flops, NOR gates, and logic drivers.

Power dissipation of the unit is only 16 watts.

Indicative of the problems of fabrication in dealing with such small parts, TI engineers said that although special tools were not necessary a 10-power microscope was employed for all assembly work.

During assembly each network is held in a jig while interconnecting strip conductors are welded to various leads. Stacks, when assembled, are next encapsulated.

• **Future applications**—Some of the immediate results of the company's work already can be visualized, Haggerty pointed out. For example, it will be possible to build a guidance computer designed for use in an air-to-ground guided missile which will weigh only 5 lbs. and occupy about 50 cu. in. Its counterpart using conventional components and design would need a total volume of 3330 cu. in. and would weigh 115 lbs.

Solid Circuits, Haggerty said, would satisfy over 95% of the circuit functions of such a system.

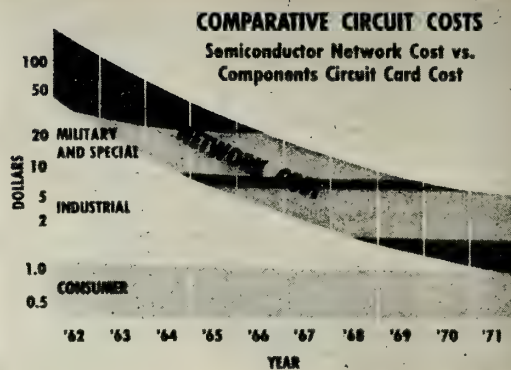
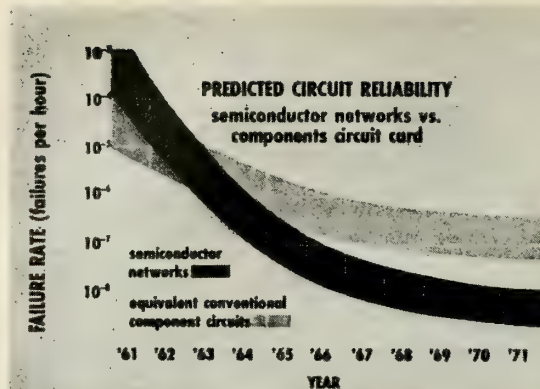
Obviously the savings of 110 lbs. could be reflected either in a sizable increase in missile range or in much heavier payloads.

A typical missile programmer today, weighing over 7 lbs. and using 220 cu. in., could be reduced with the new components and techniques to a volume of only 15 cu. in. It would weigh about 1½ lbs.

For the future, TI is developing a new Series 52 for linear functions. These new networks, according to Haggerty, will include a low-level audio amplifier, an operational amplifier, a d-c differential amplifier, a video amplifier and a power amplifier (1-3 watts).

An immediate application for these new items would, of course, be in missile-borne telemetry. As an example of size advantages, Haggerty compared a conventional PCM telemetry encoder with a microminiaturized version now being developed: size will drop from 1680 cu. in. to 30; weight from 50 lbs. to 3.

Like the digital computer, the en-



RELIABILITY AND COST predictions by Texas Instruments President P. E. Haggerty are described in curves above, com-

paring semiconductor networks with circuit boards as envisioned during the coming decade.

coder is being developed for the Electronics Technology Laboratory of the Air Force's Aeronautical Systems Division, at Wright-Patterson AFB, Ohio.

The new system, Haggerty stressed, will equal conventional units in performance and will handle both digital and analog functions. These include some analog circuit functions calling for system accuracies of 0.1%.

• **Future industry impact**—All who have followed the progress of micro-miniaturization, solid-state functional subsystems, molecular electronics (or whatever other name comes to mind) have known intuitively that savings in weight, size, reliability—and possibly cost—would someday result from this intensive national effort.

TI has performed a series of studies

to determine the future impact of such systems on the future of electronics. To illustrate, Haggerty pointed out that of the 155,000 electronics engineers and scientists now employed throughout the nation, 120,000 are involved in government work.

This figure represents a limit of sorts—and time will not increase sufficiently to meet the ever-increasing demand in the industry.

Total expenditures, he said, were roughly \$6.5 billion in 1960 for government—or so-called "military"—electronics. Thus, by simple division, total expenditure per engineer or scientist works out to be \$54,000 per year.

He then pointed out that average cost for each of these persons, including overhead, is roughly \$25,000 per year. Hence, only a little more than half the total expenditure of \$54,000 actually goes for the production of the final pieces of hardware.

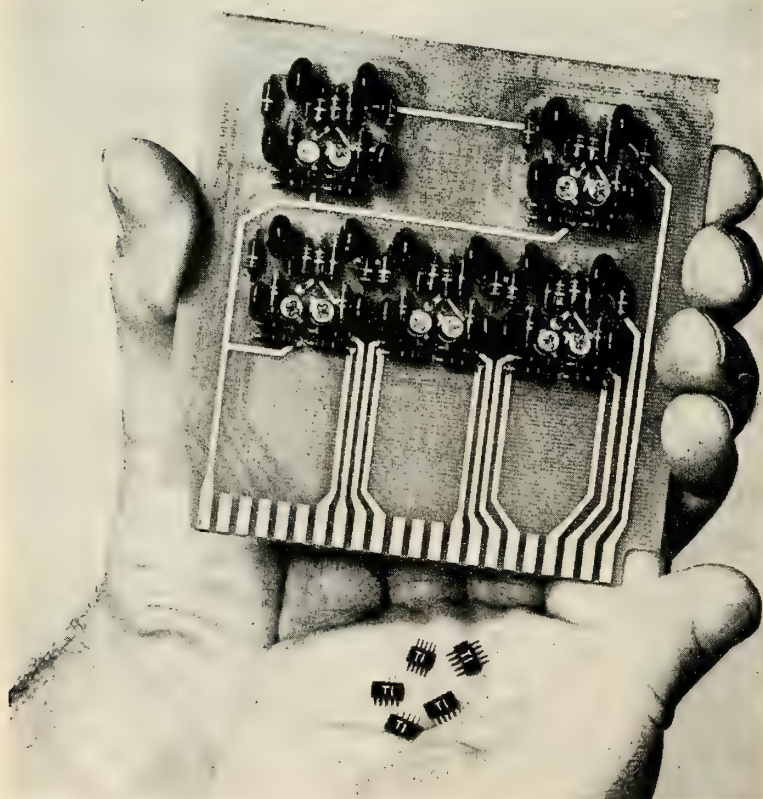
Therefore, said Haggerty, it appears that we must free these technical people from some of their present work to better utilize their efforts. Molecular electronics shows promise of doing just this.

With semiconductor networks, considerably fewer processes are required for production of both the network themselves and the systems in which they are used.

TI studies, he asserted, have shown that with a few hundred standard semiconductor networks, performing digital and analog functions, some 10% of today's specialists could be freed to tackle tasks other than just hardware development and production.

The savings in money would be about \$300 million.

Haggerty emphasized that there is also a hidden savings: semiconductor networks are inherently more reliable than equivalent circuits using conventional parts.



FIVE SEMICONDUCTOR networks functionally replace the entire conventional etched-card circuitry shown above. The new units are expected to be competitive with circuit boards of military quality by 1963, developers say.



# Data System to Sharpen Nike-Zeus

**Radiation Inc.-developed digital processor will be set up at test sites to tie radars to computer**

by James Trainor

A DIGITAL data system designed to provide a vital link between the missile tracking radars and the target intercept computer is being added to the *Nike-Zeus* ground equipment and promises to increase the overall effectiveness of the Army's antimissile missile.

Called a "Tape and Buffer System," the data processor has already been installed at Bell Telephone Laboratories' Whippany, N.J., location and is to be delivered to *Zeus* test sites at Ascension Island, White Sands Missile Range and Kwajalein Island.

In addition, Radiation Inc.—designer and developer of the system—has been awarded a contract for development of a similar system for use in an experimental prototype of the *Nike-Zeus* Defense Center.

• **Designed for flexibility**—The tape and buffer system receives information from the Target Track Radar (TTR), records this information in "real time" on magnetic tape and then translates it

into the format required for analysis by the guidance computer—an IBM 704. The system also can translate the computer outputs into suitable form for entry into the TTR.

For testing purposes, the system simulates inputs to the TTR and allows data to flow in either direction from a typewriter or punched paper tape. Finally, the system is able to read out data on an electric typewriter or punched paper tape and, utilizing the typewriter for data inputs, provides for system self-checking.

Using both real and simulated targets for system, or TTR tests, the tape and buffer units will record the essential data including:

- Encoded antenna shaft angles.
- Angular errors in tracking.
- Range and range rate as measured by digital range units.
- Variations in the gain of the IF amplifiers controlled by a digital automatic gain control loop.

The recorded data is then analyzed to determine the performance of the antenna servo loops, to determine the angle and range tracking accuracy and to evaluate the gain control loops. During simulated engagements, the system not only records the response of the radar and its tracking effectiveness but also supplies the target data to the radar for the simulated target.

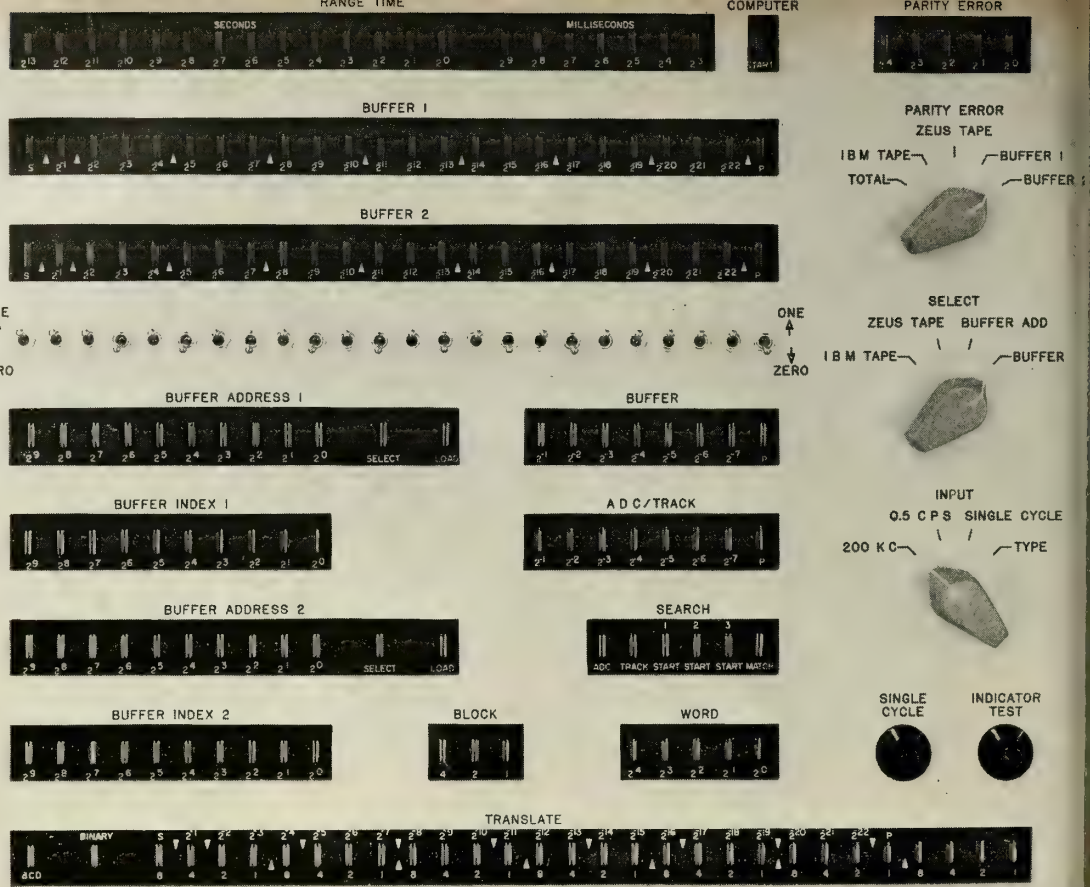
• **Components and packaging**—The equipment used in the Radiation system permits real time recording of a large amount of radar data without imposing a limitation on the frequency spectrum received.

To achieve this the tape and buffer system was designed to include electronic logic, programing controls, operating controls and a power system. It also utilizes two Ampex 400 Digital Tape Handlers, an IBM Model 82 Input-Output Writer, a Soroban paper tape punch and reader unit and a Tele-meter Magnetics Inc. magnetic core memory unit.

These components are mounted in three cabinets designed and constructed by the Western Electric Co. Modular units containing the system's logic are mounted on slide-out panels to ease maintenance and to facilitate future system expansion.



DIGITAL DATA SYSTEM being integrated into the Nike-Zeus system to provide information from the Target Track Radar in the proper format for computer analysis. The systems were designed and developed by Radiation Inc.



CLOSEUP OF CONTROL PANEL for digital system illustrates flexibility. It can be used not only to process information from

the TTR but also to simulate data for systems tests and diagnostic malfunctions in TTR and computer.

Using digital tape handlers to generate tape gaps and system operating controls for high-speed cycling, the digital system records data in blocks on the magnetic tape. The tape speed in all modes of operation is 75 in. per sec.

Using the typewriter system, it is possible to enter data or read it out of the TTR data processor in several forms—alpha-numeric, octal, binary or binary-coded decimal.

• **System operation**—The tape and buffer system receives the words necessary to make up one record in parallel form from an output register of the TTR data processor. After "buffering" in the magnetic co-incident current type memory, the records are written in the Nike-Zeus "format" on a seven-channel magnetic tape using the non-return-to-zero method.

Once translated into the Zeus format, the tape can be converted by the tape and buffer system into the word format required by the computer. This converted data is recorded on a second magnetic tape and can be transferred to a magnetic tape reader for analysis by the computer without any special input routine. The two remaining operating

modes—computer-to-typewriter and tape-to-typewriter—enable the computer to check the various TTR components.

By using specially prepared tape, the system can simulate the digital inputs to the Nike-Zeus TTR data computer. The tape is transferred to one of the tape transports in the system and there translated into the Zeus format and fed into the TTR data computer—thus supplying the simulated inputs.

By combining the two preceding operations, it is possible to evaluate both the TTR and, on a very rapid time-sharing basis, the computer reaction. The latter can be written on a second tape. Thus an analysis of the guidance computer can be performed without actually firing a missile.

The system operator by using the typewriter can formulate data in alpha-numeric, numeric or octal form and enter this data directly or from paper tape into the computer. Since the system contains a binary-coded decimal-to-binary translator, it allows the operator to enter typed numbers in the binary format normally required by the computer. For data analysis the typewriter will print out information in alpha-

numeric, binary or octal form.

One advantage of having a selective of output modes is for diagnostic checking of the TTR components. If a component is faulty in the radar, it is desirable to print out the information of the malfunction in the most useful form—in this case, alpha-numeric form. On the other hand if the tape and buffer unit or the computer malfunction, the binary or octal modes are more useful in that contents or registers or tape data can be displayed bit by bit.

The binary coded decimal is essential for operations at Ascension Island since the input data arrives in that form. Binary and octal codes are included for checking purposes so that an operator can supply input data or insert numbers into the tape-buffer system or the computer.

In overall operation, the tape and buffer system provides a real time means for digesting large quantities of information gathered by the Target Tracking Radar. And, by translating this data into suitable form for the guidance computer, it increases the effectiveness of the total Nike-Zeus system.



# Integrated Microcircuitry Matures

**Vacuum Society meeting in Washington told that deposition technique is adequate; tolerances tough**

by John F. Judge

BY 1963, evaporated, integrated microcircuitry will be manufactured in production quantities more cheaply than printed board circuits are produced today.

D. W. Moore, manager of Solid State Physics at Lear, Inc., told members of the American Vacuum Society at their 10th National Symposium that integrated microcircuitry is about to enter its adolescence—if not full maturity.

"The absolute necessity to enable us to do this is the ability of firms producing this type of circuitry to be able to deposit the active and passive components so that the desired system accuracy is consistently and reliably obtained," Moore says. "This can be done with current techniques conventionally utilized."

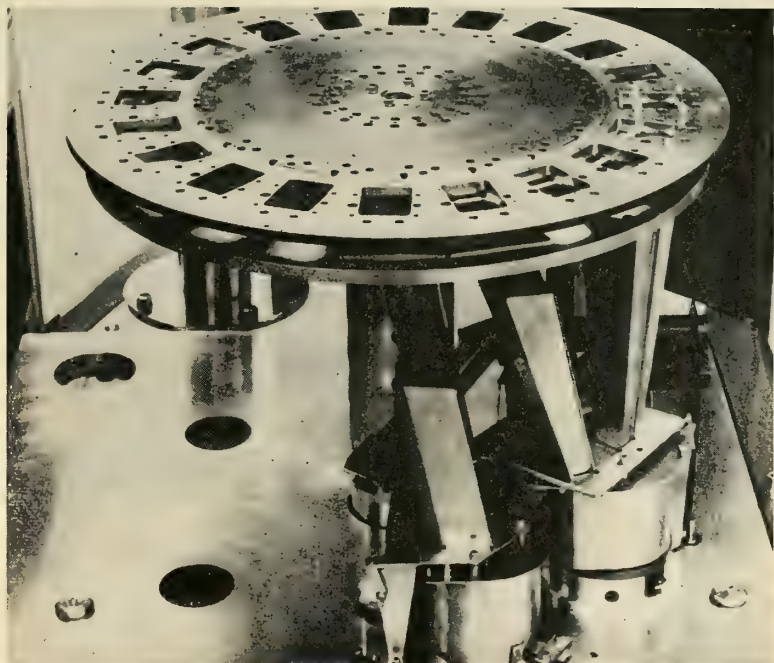
By current techniques, the Lear physicist means the thin-film deposition of miniaturized counterparts of electronic components used in conventional circuitry. Moore says microcircuitry for electronic systems is an entirely different problem from microcircuitry for demonstration or advertising purposes. System microcircuitry must perform a specific function, reliably and well—for a reasonable price.

It must be capable of exactly duplicating a conventional circuit if it is replacing an existing one which functions cooperatively with other mechanical and/or electrical equipment.

If the system is a new one, it must be possible to handle the microcircuitry in a manner of analysis which is familiar to electronic engineers and can be duplicated with reliable hardware.

• **Tolerances tricky**—The biggest problem facing the microcircuitry engineer is that of reproducing the circuit to the required operational tolerances. For example, says Moore, in a resistor pattern for an individual amplifier having 8 resistors, all 8 are deposited at one time and all are within the required tolerance of  $\pm 5\%$ .

When a pattern of this type is deposited it is imperative that the resistors



*SIMULTANEOUS DEPOSITION of twenty separate integrated microcircuits is possible with substrate and mask holders such as this unit.*

be in tolerance after evaporation and that no hand tailoring or adjusting is necessary. In cases involving unusually accurate resistors, hand work may be needed. But for conventional tolerance such work renders the fabrication costs prohibitive.

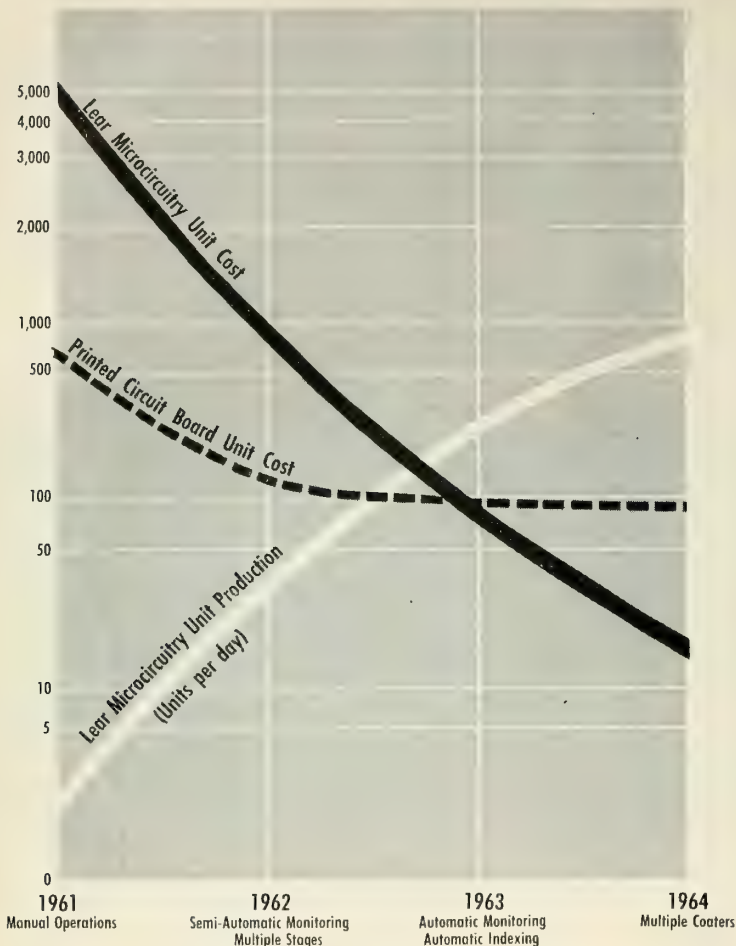
In designing thin film resistors, Moore prefers low-ohm-per-square films from the standpoint of reliability and stability. This approach means more careful masking in the depositions process.

• **Thick vs. thin**—In evaporating a resistance pattern, accurate knowledge and control of the deposition of the resistance material is a necessity. This includes knowing the change in resistance of stabilization curve of a resistor or resistor pattern after evaporation is complete.

An evaporated resistance film is initially deposited in an amorphous condition, says Moore. It must then crystallize—which changes its resistance somewhat. When the film is exposed to air, surface oxidation further affects the resistance.

Thin-film resistors should be deposited upon substrates sufficiently hot so that the mobility of the film will permit rapid crystallization. This crystallization must be complete before removal from the vacuum chamber or it will occur over a period of months, resulting in an unstable component.

If the film is too thin, atmospheric exposure will result in unpredictable resistance changes. Low-ohm-per-square films are considerably thicker than high-ohm-per-square material, and their surface-to-volume ratios will be higher.



Lear's Microcircuit Cost Projection

The change in resistance caused by surface oxidation is a function of this ratio, and the change in a thick film will be less.

Extremely thin films (less than 500 Å) are quite unstable, Moore says, and will change considerably after being delivered to the ultimate user.

This bolsters Moore's argument against high-ohm-per-square material. In depositing an accurate resistance pattern, it is obvious that if 100-ohm-per-square film is used, masks are accurate and adequate monitoring means employed, it is reasonably simple to evaporate an accurate pattern.

But if 2000-ohms-per-square film were used with accurate masking techniques, it still would not be possible to evaporate an accurate resistance pattern because of the high resistance changes due to atmospheric oxidation.

Moore maintains there is only one place where accuracy can be designed into a thin-film circuit—this is in the

evaporation mask. Masks for Lear microcircuits are etched in type 300 series stainless steel 0.005 or 0.008 in. thick.

**Precise processing**—The original circuit layout is done on Ruby Studnite Thin, a commercial stencil-cutting film, 25 times the size of the actual circuit to insure drafting accuracy. All photo reduction is done in two stages, with a Robertson Process camera; all final positives are on DuPont Cronar film.

Openings in the finished masks are often less than 0.005 in. wide. A 5% tolerance on this line width would be 0.00025 in., and all of the resistance tolerances cannot be used in the masking process. Some very careful photography is involved.

In the evaporation process, Lear employs a monitoring resistor. Its resistance is constantly checked; when it reaches a pre-determined level, the evaporation process is halted. This termination can be effected to a very high degree of accuracy, says Moore,

by using a digital ohmmeter with an automatic cut-off in the fourth digital place.

Lear handles capacitors by evaporating the electrodes and the dielectric material. Silicon monoxide is the dielectric material. The main problem is to so control the process that the deposited film is free of pin holes.

**Selective penetration**—Moore feels the prime causes of pin holes are mechanical—foreign particles spattering from the evaporation source. The reduction of such spattering is accomplished by sufficient separation between the evaporation source and the substrate.

The "Q" values of these capacitors should run between 100 and 2000. A low value is an indication of incipient or small pin holes. Moore says one way of living with pin holes is to overcoat the silicon monoxide film with a second film of transistor-grade silicon. This will fill the holes in the monoxide and have an electrical resistivity high enough to produce a capacitor with a "Q" sufficient for use in many circuits.

The use of this second film is based on the observed phenomena of dielectrics avoiding pin holes. The hole propagates through multiple layers of the monoxide. The deposition of a second electrode will short out the capacitor because of the ability of the metallic film to enter the hole.

Since the diameter of most pin holes is less than 1 micron, Moore feels he is dealing with an interesting phenomenon—the fact that materials such as dielectrics will avoid the hole while metals will freely enter.

Dielectric films cannot be monitored by resistance measurements; hence Lear experts observe the shifting color fringes due to light interferences as the dielectric film builds up on the substrate.

Moore and his associates are able to deposit capacitors to within  $\pm 5\%$  of the desired value by observing color fringes. The light is inherent in the evaporation process.

Interconnection between the capacitors and resistors in an integrated microcircuit is made by evaporated gold film deposited over a flash film of nichrome or chromium. The flash film provides proper matching between the gold and the glass substrate.

Active components, such as transistors and diodes, are now inserted into the array of evaporated passive components. Uncased types are used to permit as much volume reduction as possible. Insertion is routine and consists of a low-power microscope and a pneumatic micromanipulator.

**Active element block**—Moore says the urgent requirement in inte-

(Continued on page 49)



# A Trainer for Missile-firing Pilots



THREE OF THE COTELEC UNITS used to simulate hand-telecontrolled missiles for pilot training are shown above.

## by Jean Dansac

*Mr. Dansac is an engineer with the Cotelec Co., Boulogne, Seine, France.*

PARIS—Development of a simulator is under way to train pilots in the tricky art of shooting hand-telecontrolled air-to-air and air-to-ground missiles at the same time they are flying supersonic aircraft.

Hand-telecontrolled missiles, such as those developed by Nord Aviation, are guided from the aircraft through an omnidirectional control stick which will accelerate the missile proportionately to the deviation of the stick and in the same direction as that deviation.

The system being devised for the French Ministry of the Air Force by the Cotelec Co., designated the Simulator-Type 100, allows the pilot trainee to guide a fictitious missile into a target through an optical device. Actually a luminous spot projected to the infinite by the plane's gunsight, the "missile" and its motions are controlled by the simulation set. The functions of this latter device can be summarized as follows:

- Flight programming of the "missile" developed by the programming timing switch.

- Double integration of orders given by the telecontrol stick before transmission to the mobile spot which simulates the missile.

- Simulation of the distance between the missile and the shooting aircraft.

- Stabilization of the fictitious missile by gyros which, through their participation in the computation, make the absolute motions independent of the

shooting aircraft's motions about its center of gravity. The gyros also provide a reference for the initial position of the guiding axes.

- **Flexible, versatile system** — Mounted aboard aircraft normally equipped with hand-telecontrolled missiles, the simulator can be adapted to the fire control system without modifying the supports and wiring of the standardized firing elements.

To convert an operation aircraft into a trainer it is only necessary to replace three black boxes of the fire control system with three simulator boxes. This modification can be carried out in less than an hour.

However, since there are several types of hand-telecontrolled missiles, it is necessary to provide the pilot with the closest simulation possible between the spot of light on his gunsight and the actual missile that he carries. These differences between missile types can be compensated for by adjusting the coefficient relating to the load factor of the missile and the initial velocity conditions of the fictitious missile.

Also, in order to transmit to the mobile spot apparent motions independent of the position of the control stick, the luminous spot goes to a point of coordinates, at firing, equal to 75 milliradians in downward elevation and plus or minus 100 milliradians in azimuth—depending on whether the pilot has selected the "right" or "left" missile.

After reaching one of these positions the luminous spot comes back to the aircraft axis with an apparent elevation velocity of 65.5 fps and an azimuth velocity of approximately 197 fps. Dur-

ing the two seconds which follow, the pilot guides the luminous spot with the control stick while constantly maintaining the flight path of his aircraft.

The complete set of simulation operations "between the start of the missile and its coming at the target" is done within about 18 seconds. At the end of the sequence the spot remains motionless for several seconds so that a recording camera can take successive pictures of the missile and the spot. These are later used to evaluate pilot performance.

- **Compact unit**—After the necessary data are recorded, the various devices in the simulator automatically return to "zero" and are ready for another practice shot. The pilot is warned of the successive simulation phases by means of luminous signals transmitted through his gunsight.

The adaptation of this equipment to various aircraft of the French Air Force and Naval Air Force has been made possible to a large extent because of the easy interconnections and small volume of its components. The principal parts of the system, in addition to the gunsight and the control stick, are: the 619-cu.-in., 11.5-lb. Resolver and Power Supply Unit; the 787-cu.-in., 14.5-lb. Computer and Integrator Unit; the 171-cu.-in., 5.5-lb. Programming Unit and the 9.5-lb. Gyro Unit. The system operates on 27 volts DC and 115 v, 400 cycle power.

Although the Cotelec Simulator-Type 100 cannot hope to be 100% effective in training pilots to fire hand-telecontrolled missiles, it does provide an economical, lightweight means of teaching pilots. ■

# Gilpatric: Enemy nuclear attack would be 'self-destruction'

(Continued from page 12)

How do we go about the conversion of these vast sums into defense programs to support our national policies?

First of all, in January of this year, the President set in motion a major review of our defense posture and policies which has already brought some significant changes, including the budget increase I have just mentioned; and further changes are still being considered.

One of the President's conclusions was that our arms must be adequate to protect our commitments and ensure our security without being bound by arbitrary budget ceilings. At the same time he envisaged that military economies would result from management improvements in government and industry, and ultimately perhaps from agreements for the control and limitation of arms.

The President was determined that our strategic power must be sufficient to deter any deliberate nuclear attack on this country or its allies by being able to survive the first strike by the enemy with sufficient arms to penetrate his defenses and inflict unacceptable losses upon him.

## For 'Lower Level' Attacks

President Kennedy also called for greatly increasing our ability to handle lower levels of conflicts, including local wars and those sub-limited, guerrilla-type struggles which have constituted the most familiar threats to the free world since 1945. He has also determined to improve the flexibility of our defenses, by improving our ability to make swift, selective responses to enemy attacks on the free world regardless of time, place or choice of weapons. At the same time the new Administration embarked upon a political action program designed to reduce the danger of general thermonuclear war due to error or enemy miscalculation or the runaway spread of a smaller conflict.

Thus, while we are making all honorable efforts for a diplomatic solution to the problems of Berlin and Germany, we are intensively studying the organizational and technical aspects of our "command and control" systems to assure a controlled response to any form of aggression.

Berlin is the emergency of the moment, because the Soviets have chosen to make it so. We have responded immediately, with our western allies, by reinforcing our garrisons in that beleaguered city. We have called up some 150,000 reservists, increased our draft calls and extended the time in service of many

who are already in uniform. These are the so-called "quick-fix" measures which we have invoked to improve the western tactical position in Berlin and remind the Soviets that the city is not an open invitation to that variety of aggression which has been described as the salami, or one slice at a time, method.

## Relative Nuclear Power

But our real strength in Berlin—and at other any point in the perimeter of the free world's defenses that might tempt the Communist probes—is much more broadly based.

Our confidence in our ability to deter Communist action, or resist Communist blackmail, is based upon a sober appreciation of the relative military power of the two sides. We doubt that the Soviet leadership has in fact any less realistic views, although this may not be always apparent from their extravagant claims. While the Soviets use rigid security as a military weapon, their Iron Curtain is not so impenetrable as to force us to accept at face value the Kremlin's boasts.

The fact is that this nation has a nuclear retaliatory force of such lethal power that an enemy move which brought it into play would be an act of self-destruction on his part. The U.S. has today hundreds of manned intercontinental bombers capable of reaching the Soviet Union, including 600 heavy bombers and many more medium bombers equally capable of intercontinental operations because of our highly developed in-flight refueling techniques and world-wide base structure.

The U.S. also has 6 *Polaris* submarines at sea carrying a total of 96 missiles, and dozens of intercontinental ballistic missiles. Our carrier strike forces and land-based theater forces could deliver additional hundreds of megatons. The total number of our nuclear delivery vehicles, tactical as well as strategic is in the tens of thousands; and of course, we have more than one warhead for each vehicle.

Our forces are so deployed and protected that a sneak attack could not effectively disarm us. The destructive power which the United States could bring to bear even after a Soviet surprise attack upon our forces would be as great as—perhaps greater than—the total undamaged force which the enemy can threaten to launch against the United States in a first strike.

In short, we have a second strike capability which is at least as extensive as what the Soviets can deliver by striking first. Therefore, we are confident

that the Soviets will not provoke a major nuclear conflict.

It might be appropriate at this point to say a few words about the Soviet's announced intention to explode a 50-megaton thermonuclear device at the end of October.

Our own scientists and military leaders examined the utility of weapons of this and even larger yields several years ago and concluded that the military value was so questionable that it was not worth developing such weapons even though we had the know-how and capacity to do so. While there might be some military advantages from extremely large yields, there are also operational disadvantages.

It is therefore quite clear that the Russian's primary purpose is terror. With the customary Soviet heavy-handedness, the timing has been chosen with one eye on Berlin and the other on the 22nd Party Congress. Perhaps this is also the Soviet Union's answer to the discordant voice from its populous neighbor to the south.

As to the test itself, explosions of this size are not necessary for development purposes. As pointed out in a recent White House statement, "we believe the peoples of the world will join us in asking the Soviet Union not to proceed with a test which can serve no legitimate purpose and which adds a mass of additional radioactive fallout." If the Soviets proceed with such an unnecessary and possibly risky test, despite urgings to the contrary, we trust that this latest outrage will remove the doubts of even their most indulgent apologists among the non-aligned nations who failed to protest the Soviet resumption of testing during the Belgrade Conference.

## Strengthening Survivability

Notwithstanding what the White House called the "unconfessed political purpose" behind this particular test, we must and we do take seriously the Soviet Union's military technology and the likelihood of future improvements in its nuclear strike posture. We are therefore increasing the survivability of our retaliatory force by programs of hardening, concealment and mobility.

We have accelerated deliveries of *Polaris* submarines and hastened the development schedule for a greatly improved version of the missiles they carry. We have expanded the development of the *Minuteman*—our solid-fuel, land-launched missile—and enlarged its production capacity. We are proceeding simultaneously with the development of



advanced air-to-ground missiles, such as the *Skybolt*, in order to extend the useful life of the manned bomber further into the missile age.

To protect the deterrent effect of our existing bomber forces, we have upped the number of planes on ground alert, and we are working to increase the dependability of our warnings against surprise attack by installing bomb alarm detectors and signals at SAC bases and other key points. Our planners are working on many other important research programs such as missile defense and penetration aids, satellite-based communication systems and possible military uses of space.

In the interest of protecting our civilian population from radioactive fallout, we have made a fresh start on a national shelter program under the aegis of the Department of Defense to which have been transferred important new responsibilities in the civilian defense field.

The weapons that form the backbone of our deterrent strength are formidable, and we intend to keep them so. But if we had no effective weapons but the big ones, a small-scale Communist aggression could confront us with a choice between the risk of general war and a political retreat.

Hence we are looking to the condition of our conventional forces, so that a potential enemy may not be tempted to steal from under our noses, gambling that we would not call out the weapons of massive nuclear destruction in response to ambiguous aggression or deliberate probing by the enemy.

Let me make clear that we are seeking to acquire flexibility rather than rigidity in the options open to us. This requires a strengthening of conventional, non-nuclear arms; it does not rule out the use of tactical nuclear weapons in limited war if our interests should require.

We are placing a new emphasis on our ability to meet limited and guerrilla warfare by expanding research on conventional weapons, improving air and airlift capacities for moving large numbers of troops to crisis areas on short notice, and increasing the procurement of the weapons of limited war. The substantial additional purchases of conventional weapons and equipment include tactical aircraft, tanks, rifles, personnel carriers, artillery and stocks of ammunition.

I might note here that our Military Assistance Program is designed to deal with aggression in its incipient phases, by helping friendly nations to improve their internal security and making local wars and forays against them unprofitable. Our assistance to our NATO allies should also help to deter general war.

As the pressures have mounted on Berlin, we have retained in service or

reactivated ships and planes with tactical, troop-carrying or antisubmarine capabilities. We have at the same time started to draw on available manpower pools for substantial increases in the armed services totalling to date about 325,000 men, by extending active duty tours, stepping up the draft, and by recalling reservists to active duty.

These immediate measures are concerned chiefly with Berlin. No one can say how long that crisis will be with us, or where the next Soviet experiment in international anxiety may be scheduled. Probably we are in for a period of protracted tension and we are making our plans accordingly. Southeast Asia is currently under severe pressure, and other areas are not immune.

Obviously, it would be to the advantage of an adversary if we let him rush us into a succession of mobilizations and demobilizations according to his dictates. Instead, it is to our advantage to maintain a ready force of well-equipped regulars which can be augmented in a relatively short time by trained reserve forces.

### **Short of Fully Mobilizing**

Accordingly, the Army's current goal is to ready a number of priority Reserve or National Guard divisions for call-up on not more than eight week's notice. This Army plan will, of course, require corresponding stocks of modern weapons and ammunition to be on hand, and the complementary air and naval units must be brought to active duty status with comparable speed.

This program of accelerated reserve training and modern weapons improvement is intentionally short of full national mobilization, but nevertheless gives us a very real addition to our forces in Europe. First, we and the other Western powers have agreed to bring up to full strength our present units in the Central European Theater.

At home, meanwhile, we are converting to combat readiness the three of our Army's 14 divisions previously engaged in training missions. Later this year, therefore, this country will have ready for immediate deployment six Army divisions and two divisions of Marines, plus the two National Guard divisions already recalled and any other reserves that may hereafter be ordered to duty. Thus, if the clouds over Berlin should darken further between now and winter, the Defense establishment could move to Europe on short notice six or more divisions, more than doubling, if need be, the potent American fighting forces currently assigned to NATO. Meanwhile, large amounts of military equipment and supplies are being prepositioned overseas.

Concurrently with the Army build-up, a number of Air National Guard

fighter units have been recalled to provide the necessary air cover and support overseas, and the Air Force has also augmented its airlift capacity by canceling the deactivation of certain transport squadrons and calling up others.

For its part, the Navy is improving its amphibious transport, taking action to permit the assignment of a third carrier to the 6th Fleet in the Mediterranean, and extending antisubmarine patrols on the North Atlantic sealanes. The result will be a general strengthening of naval readiness around the world, thereby bolstering our national deterrent strength and contributing importantly to U.S. resources for limited war.

The Navy is constantly improving its vessels through modernization and the procurement of more advanced weapons systems. Nuclear submarines are entering the fleets in increasing numbers; guided missiles are replacing guns on destroyers, frigates and cruisers, and Mach 2-speed aircraft are operating from attack carriers.

Our present plan, as I have indicated, is to count on a ready reserve as a means of quick force augmentation in emergencies. The alternative, which has its advocates, would be a substantial increase in our permanent force levels. Let us take a look at the choice we face.

### **Unacceptable Alternative**

For every fighting man added to our active military forces, the cost is at least \$5000 a year just for pay and allowances, subsistence, clothing and transportation without counting the modern combat equipment he needs, ranging from infantry rifles to the latest in nuclear submarines. A larger standing Army would also mean greater overhead costs, in terms of more military installations and added administrative and support facilities. In the long run, as individual duty tours and enlistments are completed, training costs for replacements would also go up.

The ready reserve is much less costly to maintain. Members of reserve units are paid only for their weekly and annual training periods. The major items of equipment they require, such as air and sea transport, heavy artillery and tactical aircraft, need not be constantly exercised and can be provided by Air Force and Naval Reserve units when Army reservists are called to active duty.

In reviewing our current preparedness programs, which have already been brought up to record levels for non-war-time, we have asked ourselves whether we could buy enough extra protection by further enlarging our permanent forces to offset the added costs and disadvantages I have mentioned. The answer appears to be no.

We must ever be mindful, however, of the fact that the Moscow-Peiping





missiles and rockets  
special **NASA** issue  
november 27, 1961

advertising closing date: november 6





## 'The United States does not intend to be defeated . . .'

axis is capable of generating simultaneous crises in widely separated parts of the globe. The free world could conceivably be faced with critical situations at the same time in more than one area of the world. Should it prove necessary to deploy U.S. forces in support of two or more threatened areas, additional Reserve and National Guard divisions could be activated in order to provide impressive increments to our strength.

We recognize, of course, that divisions yet to be mobilized represent potential power rather than power in being. Were it to become apparent that to deal with multiple trouble situations a further increase in our permanent forces is needed, then the Congress will be asked to make the required resources available, and all of us will be called upon for new sacrifices of money, time and energy. Until that contingency occurs, our reserve program should give us strength and flexibility in the most economical manner.

### Non-military Resources

As we hasten the build-up of our conventional forces, we might remind ourselves that, after all, the nations of the NATO alliance have more people, greater economic resources and further advanced technologies than all of the

Warsaw Pact countries combined. Moreover, the Soviets may well have reason to doubt the military dependability of their European satellites in a showdown.

### Summation

Let me sum up, then, where our defenses stand today. First, we continue to rely on our strategic nuclear weapons to convince a would-be aggressor that he could not emerge standing from a general war of his own instigation and we are keeping those weapons up to date.

Secondly, we are rapidly strengthening out conventional weapons and increasing our ready reserve of trained manpower, to give us an improved, third choice between all-out nuclear retaliation and retreat.

Thirdly, we are endeavoring to strengthen and improve the military defenses of our friends in the world in accordance with their needs, with special attention to preventing or confining limited wars, subversion and guerrilla-type insurgency.

We are determined to have flexibility in our choice and mobility of weapons, and in our capacity to respond to repeated crises in the long run without the dislocation of our entire economy.

The Soviet's bluster and threats of rocket attack against the free world—aimed particularly at the European

members of the NATO alliance—must be evaluated against the hard facts of United States nuclear superiority which I discussed earlier. Although we are confident that we would ultimately prevail in a test of strength no matter what level conflict might be initiated by the Soviet Union, this does not alter our determination to seek a peaceful solution to the world's problems.

### Forcing Reds into Peace

But those who would impose a totalitarian world order and deny men and nations the right to pursue their own destinies should understand one point very clearly. The United States does not seek to resolve disputes by violence. But if forceful interference with our rights and obligations should lead to violent conflict—as it well might—the United States does not intend to be defeated.

As the President reminded the world at the UN last month, our country has both the will and the weapons to join free men in standing up to their responsibilities. We in the Defense Department believe that the proper exercise of our will and the development and management of our weapons will eventually force the Soviet Union to participate with us in a step-by-step program to guarantee the peace which many nations earnestly desire.

## Analysis Shows U.S. Still Banks on Marginal Deterrence

(Continued from page 4)

compared to U.S. ICBM production was estimated to be running at a ratio of 3 to 1. And the Russians were estimated already to have several dozen diesel-powered submarines capable of launching approximately 200-mile-range missiles.

These were the intelligence estimates behind the expected Missile Gap. They were based for the most part on what the Russians were estimated to be capable of doing. If they were correct, the United States would face a period of great peril.

However, the estimates now have been revised downward. The estimates now credit the Soviets with only about 50 to 75 ICBM's today—instead of the expected 200 to 300. The estimates contend that the Soviets did not use their full ICBM-building capacity for one reason or another.

Therefore, if the new estimates are correct, Russia will not within the coming months have enough ICBM's to de-

stroy SAC. And, on the basis of these estimates, Gilpatric can say: "We are confident that the Soviets will not provoke a major nuclear conflict."

But this is not because the United States has "tens of thousands" of nuclear delivery vehicles. It is because when faced with a potential bomber gap that failed to materialize in the 1950's, the United States "wastefully" built up its bomber fleet—and because the Russians are not believed to have built as many ICBM's as they were thought capable of building.

Through luck, the United States has apparently won a breathing space, a period in which it again has a chance to achieve a clearly dominant military position and assume the offensive in the Cold War.

Military strategists are advocating that the United States now outstrip the Soviets in the deployment of ICBM's, and at the same time beat or at least block the Soviet drive to make a pos-

sibly military end run in space.

So far, the Kennedy Administration is declining to do this.

The defense budget guidelines for FY '63 contain relatively little room for the development of military offensive and defensive space systems; military contribution of the NASA Apollo program remains in doubt.

The budget guidelines also provide only for a relatively modest build up of the ICBM force beyond the numbers already authorized. The Navy may receive six more *Polaris* submarines. The Air Force may receive two more *Minuteman* squadrons.

But any plans that would make certain the building of a clearly superior U.S. force in the coming years have been put aside to await further intelligence reports on what the Russians intend to do.

The goal remains: Just retain a margin.



# Dearth of Electronics Experts Looms

**DOD's Bridges warns that 40% gap will open in five years and will get worse; efficiency is the answer**

by Bill Wilks

THE DEMAND for electronic engineers and scientists will outrun supply 40% within the next five years.

James M. Bridges, Defense Department director of electronics, told the Los Angeles section of the Institute of Radio Engineers the situation "demands critical attention on a national basis."

Said Bridges: "Around 120,000 of the estimated 150,000 electronics engineers and scientists in the nation are presently engaged in government-supported work. The planned expansion of the nation's space program, together with a continually growing defense effort will significantly increase the number needed in government work during the next several years."

The situation will get worse, he stated, because fewer electronics experts will be coming out of school in the next few years because of a drop in number of students entering that field four to five years ago.

Bridges told M/R he believes the only solution to the problem is to increase efficiency and productivity of the individual and the company, necessitating certain changes in attitude on the part of both, as well as a change in government approach. He made these observations and criticisms:

—"The push to create is not as great as it used to be. A young engineer now says, 'I don't want to do design work. I want to direct others in that.' Everybody wants to be a chief, not an Indian."

—"There is instability among personnel in industry. Every time someone moves, there is an increase in salary. This is an incentive for a man to improve himself, not to increase his productivity."

—"I'm not sure industry as a whole is really aware of the seriousness of the problem. The government is—Secretary McNamara is. He is aware of the skyrocketing cost of engineering which has increased two-and-a-half times the cost—living increase in the last couple of years."

—"Contractors are putting more en-

gineers on a job than they need. A contractor goes into a job without a thorough understanding of the schedule. We're not sure of cost and we don't review, so we stock a lot of engineers we don't really need. I'd break it into phases and review. We could go on a fixed price at a time when we can make a good estimate.

—"There is no real incentive, no real motivation for high efficiency. In defense work, the profit percentage is low. This is one reason why the incentive is so low. If we said, 'look, fellows, we'll give a better profit, 15 per cent instead of 3 per cent, and not renegotiate it down to zero, this would be a reward for high performance. Likewise, we've had no penalty for poor work."

—"We hear there is a lot of wasted effort writing proposals. This usually requires the most creative and talented people. This situation could be improved by the government not asking for proposals from companies that are not really capable of doing the work. Of course a lot of proposals are unsolicited."

—"We need better methods of checking contractors. I don't think we have a fine-grain way of doing this."

**RADIO CORP. OF AMERICA** formed a data systems division in Van Nuys, Calif. The new division takes the place of the West Coast missile and surface radar division, and will handle all data systems activities.

**FLEXIBLE TUBING CORP.** and Kenyon Instrument Co. have merged through exchange of stock. Kenyon becomes a wholly-owned subsidiary of Flexible. The combined companies look for expanded activity in aerospace and marine fields.

**MACHINE DYNAMICS INC.** has been formed in Pasadena, Calif., to develop, design, and manufacture programmed environmental test facilities. Programed systems include shock simulators, high-force vibration equipment, dynamic loading equipment, dynamic loading and pressurization facilities, and dynamic material evaluation machines.

**TECHNICAL CONSTRUCTION CO.** was established as a subsidiary of Ets-Hokin & Galvan, Inc., electrical contracting firm.

## Financial Reports

| COMPANY                          | PERIOD         | INCOME        |               | EARNINGS     |              |
|----------------------------------|----------------|---------------|---------------|--------------|--------------|
|                                  |                | 1961          | 1960          | 1961         | 1960         |
| Celanese Corp of America         | 9 Mo. Sept. 30 | \$205,885,003 | \$202,003,190 | \$13,732,223 | \$14,595,543 |
| Douglas Aircraft Co.             | 9 Mo. Aug. 31  | 618,290,832   | 859,540,578   | 4,485,938    | —21,868,045  |
| Electronic Specialty Co.         | 9 Mo. Sept. 30 | 20,241,290    | 7,651,175     | 887,180      | 13,159       |
| Elion Instrument, Inc.           | Year, July 31  | 205,403       | 25,268        | —224,108     | —139,897     |
| Esprey Mfg. & Electronics Corp.  | Year, June 30  | 5,139,089     | 3,696,853     | 189,495      | 172,490      |
| FMC Corp.                        | 9 Mo. Sept. 30 | 315,565,839   | 275,139,466   | 18,737,820   | 16,563,244   |
| Hagan Chemicals & Controls, Inc. | 9 Mo. Sept. 30 | 30,540,290    | 30,384,696    | 1,361,765    | 1,390,244    |
| Minneapolis-Honeywell Reg. Co.   | 9 Mo. Sept. 30 | 333,846,759   | 312,806,497   | 16,312,254   | 18,358,826   |
| Parker-Hannifin Corp.            | 3 Mo. Sept. 30 | 13,414,304    | 10,778,180    | 690,580      | 393,520      |
| Radiation Inc.                   | Year, Aug. 25  | 26,244,383    | 23,155,845    | 587,839      | 184,787      |

# NASA Hunts 'Unconventional' Rocket

NASA IS PURSUING the search for a radically new rocket to replace today's Goddard-based "Model T" design.

The space agency disclosed this week that Aerojet-General Corp. and Rocketdyne Division of North American Aviation Inc. are engaged in studies of new techniques of building large liquid rocket engines.

The 10-month contracts—worth \$185,000 each—were awarded in April, 1961. Final reports are due in February 1962. Work on the proposals may then continue for several years.

NASA officials said that while the current program is merely in the study phase, "we do not expect a negative report." They said improvements in current large liquid rockets engines are necessary if the U.S. is to equal or sur-

pass the Soviet Union in the space race. DOD is already supporting similar studies and the NASA program will complement that effort.

• **Cheaper, too**—Prime purpose of the new studies is to determine what types of "unconventional" engine and vehicle designs are feasible.

"Unconventional" is defined by NASA officials as an engine which does not use a de Laval nozzle, does not use gimballing for thrust vector control, and which has a better "alliance" structure-wise between the engine and vehicle than current liquid rocket engines.

There are good reasons to believe, the officials said, that an unconventional engine which is rigidly mounted, but still provides vector control would be lighter, more reliable and cheaper than current rocket engines.

A lid of secrecy has been clamped on the engine concepts under consideration. Space agency officials said, however, that:

—The engines would be used on big boosters with 2 million to 24 million lbs. thrust. It is possible that use of upper stages could come later.

—Propellants for purposes of the studies are liquid oxygen/hydrocarbon and liquid oxygen/liquid hydrogen.

—The engine's thrust will be constant—not variable.

Among the engine concepts which are certain to be considered under the NASA program are Rocketdyne's expansion-deflection and reverse flow nozzle concepts and General Electric's plug nozzle proposal.

The "reverse flow" concept has been classified by the DOD.

The "expansion-deflection" nozzle, however, involves the expansion of the exhaust gases around the corner of a centrally located plug. The flow is then deflected by the wall contour of a conventional-looking exhaust chamber which is about half the length required for conventional engines in the same thrust level.

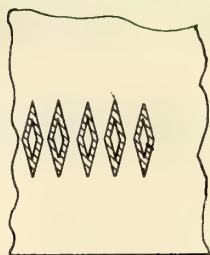
• **Plug nozzle in**—Rocketdyne says that the E-D nozzle incorporates several advantages as reduced weight and length, reduced cooling requirements, good performance at high and low altitudes, and a possible simplified thrust vector control.

In GE's plug nozzle design, propellants would be ignited in a ring of small segmented chambers around the outside base of a large conical spike or plug. Unlike clustered rocket designs now under development, combustion cells would be designed specifically to be integrated into a single power package.

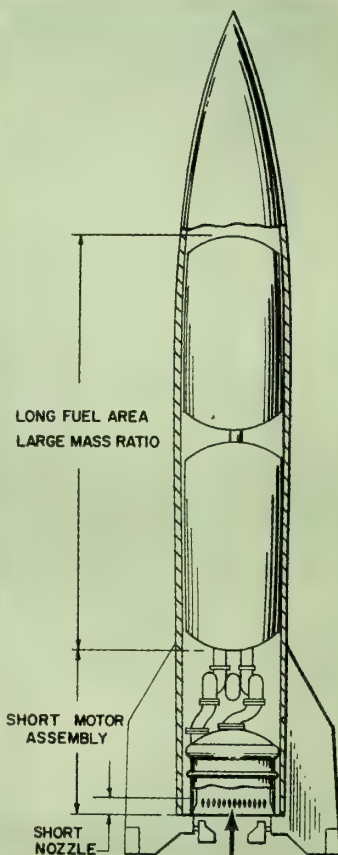
A large portion of the gas expansion would occur outside the thrust chamber. Since these supersonic gases would be self-adjusting, as surrounding air becomes increasingly rarified during rocket ascent, the configuration would be more efficient at low altitudes than a conventional clustered engine like Saturn, it contends.

Meanwhile, it was also learned that Dr. Werner von Braun, Director of NASA's Marshall Space Flight Center, has been awarded a patent on an unconventional rocket engine. He proposes to increase engine performance by cutting the size of the engine by removing the throat of the nozzle (see drawing).

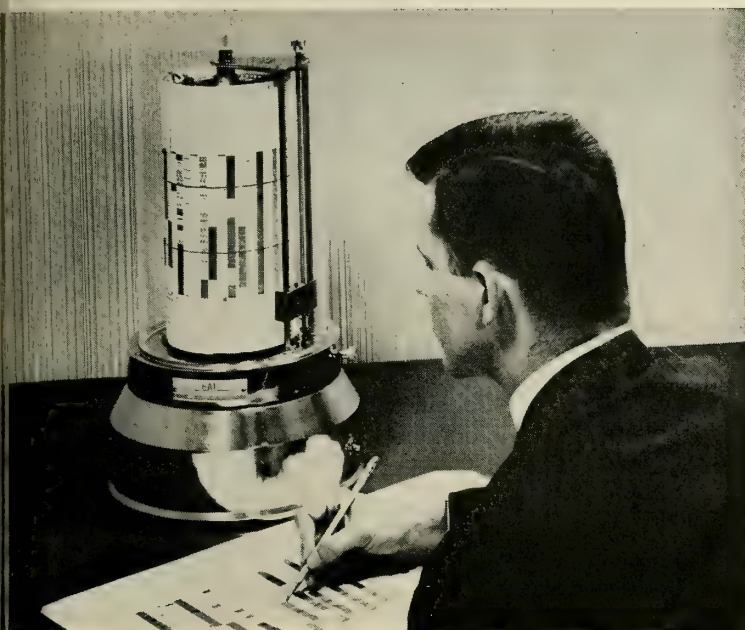
## Von Braun Patents 'Short Nozzle' Rocket



In a patent awarded earlier this year (No. 2,967,393) for a "Rocket-Propelled Missile," inventor Wernher von Braun claims devising a foreshortened rocket nozzle. Objectives are to get a vehicle with a high mass-ratio, more room for fuel tanks, and one whose combustion chamber and nozzle have cylindrical walls. Diamond-shaped tubes shown in cross-section (above) and in "short nozzle" (right), "are spaced from each other . . . by an amount sufficient to provide the proper nozzle throat area and mouth area." Missile is steered by carbon vanes in the exhaust.







## New Product of the Week:

### Recorder Monitors Up to 40 Machines

A DESK-TOP-SIZE device that monitors and records the efficiency of utilization of up to 40 production or data-processing machines is being manufactured by Electronic Associates, Inc.

The bar chart recorder operates remotely from production areas and provides cost and production control information on a continuous-bar chart.

The unit provides management with an accurate graphic picture of each machine's productive and nonproductive effort. It can also provide such information as the operator number, job and shift number corresponding to any manual report on the part of the operator.

Every 20 seconds the recorder samples and graphically records each machine's performance. If the machine is operating, the fact is recorded with a short horizontal line in the appropriate bar or channel area. Lines do not appear if the machine is idle. The recorder is available with charting time of 9, 17, or 24 hours per chart.

Circle No. 225 on Subscriber Service Card

### Temperature Detector

A resistance temperature detector with resistance wires interwoven with fiberglass threads to provide a rugged, accurate and inexpensive sensing ele-



ment is available from Control Indicating Corp. The detector is a ribbon-type with inherent design capability providing greater resistance per linear inch, ability to fit curved or irregular surfaces with almost complete absence of strain gage effects. The units are manufactured with either platinum or nickel wire and are suitable for use up to 1000°F.

Circle No. 226 on Subscriber Service Card

### Programmable Power

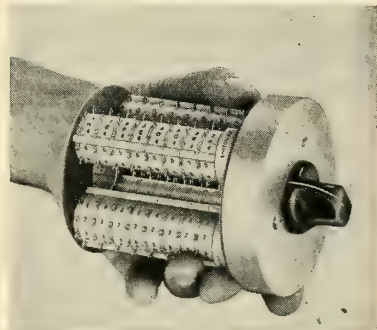
Carad Corp. is marketing a line of programmable high-voltage regulated power supplies, suited to the requirements of automated checkout systems

for testing electronic equipment and component assemblies. The d-c output voltage is programmable over the range of 100 v to 3000 v by connecting an external resistor across a pair of terminals. The programming relationship is:  $\text{output voltage} = 100 \text{ v} + .001 \times \text{programming resistance in ohms}$ . Either polarity output terminal can be grounded. Output current range is 0 to 10 ma, with a current limiting circuit which operates at 12.5 to 15 ma. Output ripple is well below 5 millivolts rms, and the response time to a programming command for increased output voltage is 25 volts per millisecond.

Circle No. 227 on Subscriber Service Card

### Interrogation Switch

A missile interrogation switch featuring any degree of indexing is available from Janco Corp. The Series 1900 miniature is ideally suited for incorporation into a gear-driven gang installation to provide a Series 2000 switch assembly having as many as 12 positions with



a total of 96 poles. Variations of this latest Janco switch with respect to total number of positions and poles are available. All switches can be readily adapted for remote solenoid operation. The switch is designed and built to exceed MIL-S-6807A. Because it is totally enclosed, it affords maximum protection against adverse conditions.

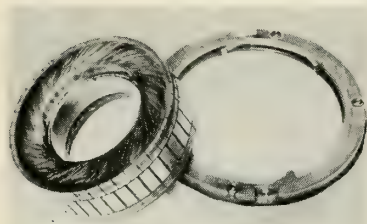
Circle No. 228 on Subscriber Service Card

### D-C Torque Motors

Servo Components Division of Giannini Controls Corp. is producing a direct-drive d-c Torque Motor series for stringent military and industrial use.

Designed expressly for applications requiring a very high order of angular resolution and/or response at the load, a direct-couple torque motor eliminates the gear train with its inherent drawbacks of elasticity, back-lash and attenuation of response.

Standard models range from peak



torques of 20 oz.-in. to 350 oz.-in. Model DCTM 29-2 features peak torque of 60 oz.-in. with input power of 32 watts.

Circle No. 229 on Subscriber Service Card

## Predetection Magnetic Tapes

Heavy-duty, high-resolution instrumentation magnetic tapes, created for wide-range predetection recording, are available from Minnesota Mining and Manufacturing Co. The tapes, named Heavy-duty Instrumentation Tapes Nos. 998 and 999, are extra rugged and capable of recording very short wave lengths. The 0.43 mil high-potency oxide coating is ultra-smooth, assuring faithful reproduction of very high frequencies, a paramount requirement of predetection recording.

Circle No. 230 on Subscriber Service Card

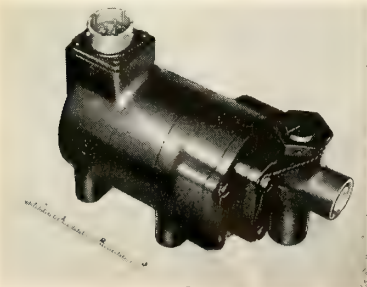
## Slide Screw Tuners

Waveline, Inc. is marketing a complete line of Waveguide Slide Screw Tuners to cover the frequency range of 5.85 to 40.0 kmc. This complete series is a group of six standard catalog models designed for minimizing VSWR values in a waveguide transmission system. They are used primarily to match various microwave devices and to determine the position and magnitude of matching structures of new devices being designed in the laboratory.

Circle No. 231 on Subscriber Service Card

## Cooling-System Pump

A pump for cooling systems on electronic and other precision equipment is available from Lear, Inc., Lear-Romec

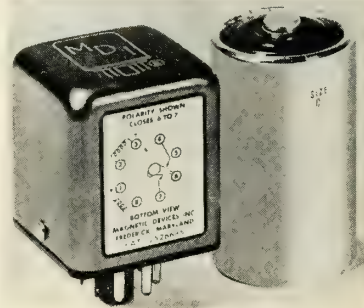


Division. The RG17400 is an electric motor-driven spur pump designed for operation in the new dielectric coolant fluids. The motor is a submerged type, to reduce weight and size in self-contained pump-motor assemblies. The RG17400 has an integral relief valve set to furnish flows from 1.5 to 2.5 gpm at pressures to 225 psi. Other models in the series have flows from 0.5 to 3.0 gpm and pressures to 400 psi.

Circle No. 232 on Subscriber Service Card

## Polarized Relays

Small size, sensitivity and high speed characterize the MSI Polarized Relays available from Magnetic Devices, Inc. They provide wide selection of design parameters through almost unlimited combinations of coils, contact materials and arrangements, and adjustments in one compact size. One



or two coil units on 8-pin octal base, and three or four coil units on 12-pin plug-in base are available in side-stable, spring-biased and center-off configurations. Switching speed is on the order of one millisecond.

Circle No. 233 on Subscriber Service Card

## Synchronous Motor

Kearfott Division, General Precision, Inc. is producing the T170-001 size 15 synchronous motor for use in such applications as ground support equipment, timing devices, recorders and wherever constant speed is required despite load or line voltage variations. The standard synchronous motors are 6-pole, 115-volt, 400-cycle units having a synchronous speed of 8000 rpm.

Circle No. 234 on Subscriber Service Card

## Floated Gyro

A rate-integrating gyro that performs with a high degree of reliability even when subjected to high temperatures and radical changes in tempera-

ture is available from Lear, Inc. Model 1078 floats in a capsule of special low-viscosity fluid that insulates sensitive portions of the gyro from shock, vibration, and extremes in temperature. The floated feature greatly reduces changes in bias drift and mass unbalance drift. The unit has proven its ability to perform reliably both under laboratory tests and actual missile flights.

Circle No. 235 on Subscriber Service Card

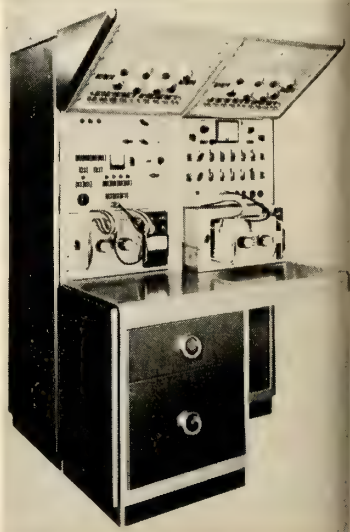
## Semiconductor Sub-circuits

Utilizing a "match maker" process to meticulously select and closely match component parameters, Continental I.V. Corp. is producing a line of high reliability, packaged component assemblies. Named Compac Welder Sub-Circuits, these devices feature close-tolerance, resistance welding of intercomponent connections. Typical circuit-functions include: flip-flops, logic, voltage reference and regulation, demodulator, high voltage and bridge rectification. The circuit designer can select from four basic case styles; tubular, disc, rectangular or square, with choice of lead configurations (axial, single-ended radial) and number of leads, in a variety of sizes according to his requirements.

Circle No. 236 on Subscriber Service Card

## Tachometer Console

A tachometer test console designed to evaluate the operating characteristics of both the integrating and damping tachometers at a temperature range -60° to 220°F is being marketed by the Instrument Division of Americ Electronics, Inc. The test console speeds up the testing process of the high-precision servo components by 800%.





provides the test components with the temperature environment, excitation, and metering facilities to determine their transformation ratio, phase shift as a function of the operating temperature environment, linearity, and speed characteristics.

Circle No. 237 on Subscriber Service Card

## Sinusoidal Oscillator

Solid State Electronics Co. is marketing a Model S-200 silicon transistor sinusoidal oscillator. The unit is completely epoxy encapsulated. Frequency stability as a function of supply voltage and temperature have been emphasized, together with rugged reliability. Power requirements are extremely low. This



oscillator makes possible the concentration of a large number of discrete control and information functions per unit volume and weight.

Circle No. 238 on Subscriber Service Card

## Portable Punch Press

Modern Manufacturing Co., Inc. is marketing a portable punch press known as the Porta-Press that exerts 1000 lbs. but weighs only 17 lbs. Punch and dies can be easily replaced to punch out holes that are round, square, rectangular, or of any other shape up to 1 in. in diameter, up to 3/16 in. thick minimum and 1/8 in. steel. This press can be used either as a portable or on assembly.

Circle No. 239 on Subscriber Service Card

## Electronic Micrometer

An electronic micrometer precision-measuring system, which displays exact measurements to 10 millionths of an inch on a 5-digit counter and automatically plots the values on a chart recorder, is available from J. W. Dice Co. Readings are taken on a one-minute or any pre-selected time cycle. Micrometer head is temperature-compensated. Read, control unit and recorder may be located remotely from each other.

Circle No. 240 on Subscriber Service Card

## A-C Voltage Standard

Tensor Electric Development Co., Inc. has announced the production of Model 6010 a-c voltage standard. This unit is said to be an a-c counterpart of the d-c standard cell. The application of the Model 6010 is as a voltage reference for a-c calibration work. At output voltage of 100v, accuracy is  $\pm 0.1\%$ , output frequency 60 cps internal or 50-7500 cps with external ocs, output current up to 10 ma, input power 105-130v single phase a-c at 60 cps, size 8 in. H x 8 in. L x 6 in. D, weight 10 lbs.

Circle No. 241 on Subscriber Service Card

## Detector Amplifier

A 5mc detector amplifier for wide-band, frequency-modulated signals is available from Dynatronics, Inc. The model 5100 is designed for recovering PCM, PAM, and FM telemetry signals which have been detroyed to a standard 5mc IF frequency. An integral part of the 5100 is a high-gain, wide-band d-c amplifier following the discriminator which is capable of driving a long 75 ohm coaxial line.

Circle No. 242 on Subscriber Service Card

## Microwave Windows

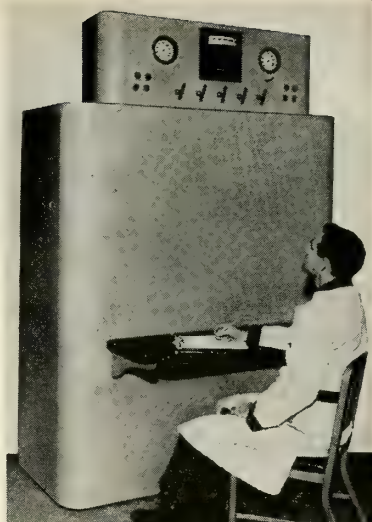
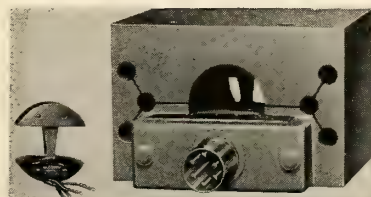
Ceramics International Corp. is producing ceramic microwave windows with metal window envelopes of various sizes. Special CI metalizing techniques eliminate the problem of braze joint overlap on the plane of the window. Extreme purity is maintained by contamination-free production methods. The windows are produced in sizes from 3/16 in. to 3 in. diameter, down to 0.010 in. thickness, and are available in rectangular and circular shapes.

Circle No. 243 on Subscriber Service Card

## Force Measurement Device

A force measurement device is available from Flui-Dyne Engineering Corp. Known as the Flex-Cell, the unit accurately converts a particular component of force in a measurement system into an electrical signal. This is done without auxiliary mechanical or electrical devices for isolating the force or weight to be measured. The cell has low deflection and high frequency response. The unit safely withstands moment inputs.

Circle No. 244 on Subscriber Service Card



## Pressure Research Unit

A self-barricaded high-pressure laboratory unit is available for research operations involving pressures to 5000 psi and temperatures to 650°F from Autoclave Engineers, Inc. Besides being self-barricading, the unit is easily movable, providing maximum flexibility in location. The unit is compact and fully equipped to include pressure vessels, valving, tubing and instrumentation, and is shipped ready for connection to existing utilities.

Circle No. 245 on Subscriber Service Card

## Miniature Clutches

Precision Specialties, Inc., is marketing a stock series of miniature clutches that transmit up to 10 in.-lbs. of torque for coupling or through shaft applications. Clutches up to 200 in.-lbs. are available on special order. Units are simple in design for maintenance-free operation and provide a positive displacement drive. They operate up to 1800 rpm without lubrication, due to oil-impregnated, sintered alloy construction, and may run at higher speeds when lubricated.

Circle No. 246 on Subscriber Service Card

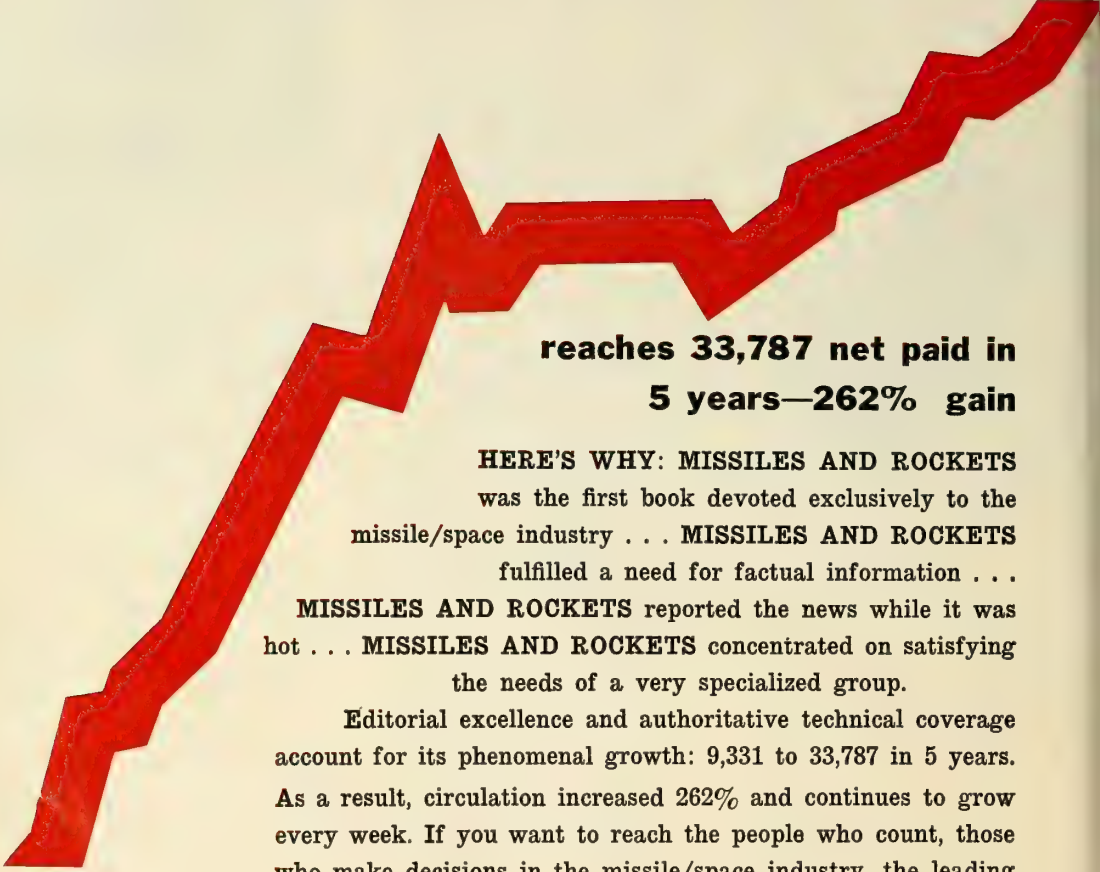
## Ceramic-to-Metal Housings

High-temperature ceramic-to-metal housings capable of withstanding temperatures to 1700°F are available from Advanced Vacuum Products. ADVAC rectifier housings have high metal strength and excellent dielectric properties, combined with a positive hermetic seal. Sheer strength in the order of 15,000 psi and thermal shock resistance at temperatures of 1000°F, coupled with high thermal conductivity, are characteristics of the vacuum seal, leak-tested  $1 \times 10^{-9}$  cc/sec.

Circle No. 247 on Subscriber Service Card

# CLIMB FASTEST RATE OF

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every week. If you want to reach the people who count, those  
who make decisions in the missile/space industry, the leading  
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\* Subject to audit

January, 1957  
9,331



## missiles and rockets

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1001 VERMONT AVENUE, N.W., WASHINGTON 5, D. C.





# contracts

## NASA

- 19,000,000—Douglas Aircraft Co., Santa Monica, Calif., for 14 Delta three-stage rocket vehicles. (Company said about 1/3 of money will be distributed among subcontractors, principally Aerojet-General, which makes Delta's second-stage rocket.
- 1,718,076—Air Products and Chemicals, Inc., Allentown, Pa., from Marshall SFC, for construction of liquid hydrogen servicing system to be used in fueling upper stages of later Saturn vehicles launched from Cape Canaveral.
- 1,000,000—Westinghouse Electric Corp., Pittsburgh, for an arc heater—most powerful ever made—and power supply for space program testing work at Langley AFB.
- 73,000—Military Electronics Div., Motorola Inc., Scottsdale, Ariz., from Jet Propulsion Laboratory, for blockhouse console control units for Rangers 3, 4 & 5.

## NAVY

- 10,900,000—Westinghouse Electric Corp., for continued development of nuclear propulsion for Navy ships.
- 3,000,000—Allegany Ballistics Laboratory, Pinto, W. Va., for continued research on solid propellant to be used for Polaris.
- 1,750,000—Lockheed Missiles and Space Co., Sunnyvale, Calif., for Polaris static test vehicles.
- 1,570,504—Texas Instruments, Inc., Dallas, for engineering and manufacturing services to provide developmental guidance and control assemblies for Shrike air-to-surface antiradar missile system.
- 1,315,000—Aerojet-General Corp., Azusa, Calif., for design and development of two sets of communications systems equipment.
- 508,500—Schaeffert Engineering, Pennsauken, N.J., from General Dynamics, for accelerometers to be used on Terrier and Tartar missiles.
- 360,000—Cardion Electronics, Inc., Westbury, N.Y., from BuWeps, for weather radar equipment.

## AIR FORCE

- 3,360,000—The Hallcrafters Co., Chicago, for production of countermeasures transmitting sets for B-52 bombers (two contracts).
- 2,155,000—Dynamics Corporation of America, New York City, for engine power generator sets (may also be used as "stand-by" sources of electricity for such critical purposes as missile firings).
- 1,181,368—The Boeing Co., Seattle, for additional Minuteman missile assembly facilities at Air Force Plant 77, Hill AFB, Utah.
- 575,000—RW Div., Thompson Ramo Wooldridge Inc., Los Angeles, from Cubic Corp., for six AN/UYS-1 "Stored Logic" computers for Radar Chain Acquisition System of Atlantic Missile Range.
- 584,807—Yardney Electric Corp., New York City, for silver-zinc batteries for Bomarc missiles.
- 21,258—United ElectroDynamics, Inc., United AeroSpace Div., Los Angeles, from The Boeing Co., for development and production of a digital telemetering system and various items of ground support equipment for operational Minuteman program.
- 500,000—Texas Instruments, Inc., Dallas, from Autonetics Div., North American Aviation, Inc., for follow-on orders of electro-optical instruments used in alignment of Autonetics' inertial guidance systems for Minuteman.

## ARMY

- 987,000—Raytheon Co., Andover, Mass., for missiles and rockets, October 30, 1961

production of high-power radar illuminators for the Hawk missile system.

\$990,000—Melpar, Inc., Falls Church, Va., for research and development.

## MISCELLANEOUS

- \$5,000,000—Electronic Assistance Corp., Red Bank, N.J., from Maintenance Service Supply Agency (NATO) for electronic equipment.
- \$500,000—United Technology Corp., Sunnyvale, Calif., from Navy and Air Force, for research in fundamental phenomena of combustion in new areas, dynamics of two-phase flow in rocket nozzles, and development of tubular nozzle systems for solid-propellant motors.
- \$400,000—Infrared Industries, Inc., Waltham, Mass., from Navy, General Electric and Flugraterwerke Bondensee GmbH, for infrared detectors and optical filters for use in air-to-air missiles.

## OPPORTUNITIES

National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. Operate, maintain, and logistically support certain portions of the Project Mercury ground tracking stations.

The NASA/GSFC Procurement and Supply Div. has issued RFP VN-4275 for operation, maintenance, and logistic support services for five Project Mercury ground tracking stations located in Bermuda, Guaymas, Canary Islands, Keno and Zanzibar; O&M of the Wallops Island demonstration site; O&M of the test aircraft; engineering support for the entire

Mercury network consisting of fourteen stations and the establishment and maintenance of a NASA depot for logistic support of "Mercury Tracking Stations."

Proposals are due to be received at the NASA Procurement Office, Goddard Space Flight Center, Greenbelt, Md., on or before Nov. 17, 1961.

The following firms have been invited to participate: American Hydrotherm Corp., Long Island, N.Y.—The Lummis Co., Washington, D.C., Attn: Marvin Marcus—The M & T Co., Philadelphia, Pa., Attn: Sam McKeegan—Radio Corp. of America, Camden, N.J., Attn: W. P. Davidson—Federal Electric Corp., Paramus, N.J., Attn: J. G. Mowder—Western Electric Co., Inc., New York City, W. H. Doherty—Lockheed Aircraft Corp., Burbank, Calif., Attn: W. G. Myers—Collins Radio Co., Dallas, Tex., Attn: M. A. Elbourn—The Bendix Corp., Baltimore, Md.—H. L. Yoh Co., Inc., Philadelphia, Pa.—Page Communications Engineers, Inc., Washington, D.C.—Vought Range Systems, Dallas, Tex.—Land-Air, Inc., Chicago, Ill., Attn: G. N. Johansen—Hughes Aircraft Co., Los Angeles, Calif., Attn: M. A. Zullo—Advanced Communications Engineering, Washington, D.C., Attn: H. P. Livingston.

It is suggested that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.



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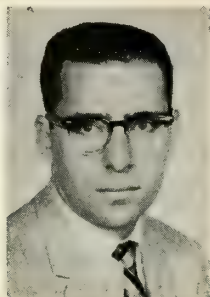
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# names in the news



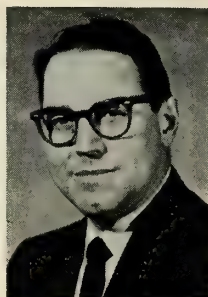
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NICHOLS

**J. Benham Malcolm:** Named executive assistant to the president of Information Retrieval Corp. of Washington, subsidiary of Information for Industry, Inc., Washington, D.C. Malcom formerly was with Teleregister Corp.

**Dr. Milton M. Klein:** Plasma physicist and former consultant to GE's Missiles and Space Vehicle Dept., joins staff of Geophysics Corporation of America, Bedford, Mass., where he will be associated with studies of new space weaponry and nuclear explosion detection research.

**Dr. G. J. Harbold:** Joins the Life Science Dept., Naval Missile Center, Pt. Mugu, Calif., as Bio-Project Acoustics Director. The new post, established by BuWeps, involves high-intensity noise from naval weapon systems, missiles and aircraft, and the effects of this noise on hearing. The third facet of the job will be the establishment of a naval technical hearing school at Pt. Mugu. Dr. Harbold also will be a representative of the Bureau of Medicine and Surgery at Mugu.

**H. E. Kurzweg:** Formerly with Dage Div., Thompson-Ramo-Wooldridge, Inc., appointed applications engineer for Cohu Electronics, Inc., Kin Tel Div., Beverly Hills, Calif.

**W. L. Whittier:** Named vice president-deputy general manager; **J. O. Moxness,** vice president-commercial sales; and **Leo J. Devlin,** vice president-engineering and product development, at the aircraft division, Douglas Aircraft Co. **R. L. Johnson,** director of product development for the missiles and space systems division, made a division vice president. **J. R. Allen,** general manager of the Tulsa division, will be a vice president of that division.

**Kenneth D. Christensen and Harold L. Flowers:** Named proposal manager and general manager of engineering, respectively, in the Electronics Operation of Avco's Electronics and Ordnance Div., Evendale, Ohio.

**Dr. Stanley Hills:** Appointed to the staff of the Industrial Group, Electric Storage Battery Co., Philadelphia.

**Dr. G. Lloyd Martin:** Formerly assist-

ant professor of chemistry, University of Alabama, appointed assistant general manager, Metals Div., National Research Corp., Cambridge, Mass.

**Murray Falkowitz:** Named manager, project management office: **James M. Harley,** manager, systems engineering dept., Reconnaissance Systems Laboratory, Sylvania Electric Products, Inc., Mountain View, Calif. **Edward G. Dooley** named aerospace products manager for Sylvania's Data Systems Operations, Needham, Mass.

**Dr. Harry E. Weaver:** Appointed manager of optical pumping and cryogenics research; **Dr. James T. Arnold** appointed manager of research in geophysics and space physics, Instrument Div., Varian Associates, Palo Alto, Calif.

**David Saxe:** Joins Atomics International, a division of North American Aviation, Inc., as manager of administration. He formerly was deputy manager, Chicago Operations office, Atomic Energy Commission.

**Carl A. Georgi:** Named assistant general manager, Friez Instrument Div., The Bendix Corp., Baltimore.

**D. C. Arnold:** Named chief engineer, Radio Corporation of America's Aerospace Communications and Controls Div., Defense Electronic Products, Camden, N.J. Prior to joining RCA, Arnold served as vice president, Alpha Corp., a subsidiary of Collins Radio Co. **Lawrence M. Falk** named manager, Support Engineering, Data Communications and Custom Projects Dept., in RCA's Electronic Data Processing Div., where he will be principally concerned with USAF's Combat Logistics Network.

**Peter N. Lensi:** Appointed vice president, Hummel Chemical Co., Inc., New York City.

**Cmdr. L. E. Kirk, Jr. (USN-ret.):** Formerly aide and special assistant for aviation to the secretary of the Navy, appointed assistant to the president of Fairchild Stratos Corp., Hagerstown, Md.

**James F. Healey:** Appointed vice president of Minneapolis-Honeywell's Aeronautical Division. Healey also is general

manager of the division's St. Petersburg Fla., plant.

**Dr. Theodore H. Maiman:** Elected vice president of Quantatron, Inc., San Monica, Calif. Formerly Dr. Maiman was director of the company's Applied Physics Laboratory.

**Dr. Peter L. Nichols, Jr.:** Former director, Space Sciences and Propulsion Division, Stanford Research Institute, appointed senior scientist of Aerojet-General Corp. solid rocket plant, Sacramento, Calif.

**Richard A. Hagberg:** Former controller and assistant to general manager Components Group, Litton Industries, promoted to vice president and general manager, Triad Transformer Corp., a division of Litton Industries. Prior to joining Litton, Hagberg was with Lockheed's Missiles Division.

**Richard P. Conniff:** Former marketing manager, Avco's Research and Advanced Development Div., joins American Machine & Foundry Co.'s Government Products Group as manager of its Washington regional office.

**Leonard A. Henry:** Joins Washington Technological Associates, Inc., as manager Industrial Planning. With the Navy Weapons Plant, Washington, D.C., for years, he last headed the Program Division, Industrial Control Dept. **Robert Pyles** named WTA's manager of Quality Control.

**Ralph L. Shapcott:** Formerly with Detroit, Inc., appointed general manager GPE Controls, Inc., Chicago, a subsidiary of General Precision Equipment Co. under operating control of GPI's Link Division.

**Warren E. Racine:** Appointed assistant to general manager, Traid Corp., Encinitas, Calif. Prior to joining Traid, Racine was with The Martin Co. at Vandenberg AFB.

**Max E. Norman:** Appointed head Heavy Military Equipment Dept.; **Richard W. Knight,** head of Avionics and Electronics Dept.; and **Benton H. Brotherton,** head of Chemical Operations Dept.—all Armament Div., Universal Match Corp., St. Louis.



(Continued from page 32)

ated microcircuitry is the ability to evaporate active elements.

Two approaches show promise. The first is to deposit single-crystal semiconductor films onto the microcircuit substrate. In this case it is highly desirable to be able to evaporate the semiconductor material onto a foreign substrate which is a good dielectric.

Lear is currently evaporating N- and P-type germanium in single crystal form, and N-type silicon has been used. Since the single crystal is normally an

N-type film, the P-type is obtained by co-evaporation of antimony. Point-contact diodes have been made with this film material, says Moore, and work is progressing on overlapping junction formation.

The second approach, which appears to be the more interesting, is the use of the tunneling phenomena, in extremely thin films (10 to 70 Å). This work, says Moore, has been pioneered by Dr. C. A. Mead of California Institute of Technology and other organizations.

An ability to deposit active elements will have a substantial effect in reducing the production cost of the integrated microcircuit.

Lear is currently working on production equipment aimed at evaporating a number of microcircuits with one system pump-down. The production of a resistance pattern in a microcircuit is a one- or two-minute operation, but the pump-down for a single evaporation may take as long as two hours due to the necessity of heating the substrate and the holding fixture.

Moore says there is enough to be gained by using current, conservative state-of-the-art evaporation means to attain a 10-to-1 volume reduction without resorting to techniques which are, at this time, marginal. \*\*

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## OCTOBER

- 1961 Aero/Space Fluid Power Conference, seminar sponsored by Aero Hydraulics Division of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 30-31.
- Radio Fall Meeting, sponsored by PGED, BTR, RQC, EIA and IRE, Hotel Syracuse, Syracuse, N.Y., Oct. 30-31.
- Aeronautical Systems Division, Air Force Systems Command, symposium on Aerothermoelasticity, (by invitation), Biltmore Hotel, Dayton, Ohio, Oct. 30-Nov. 1.
- National Association of Corrosion Engineers, Northeast Regional Meeting, New York City, Oct. 30-Nov. 2.
- American Society for Testing Materials, Pacific Area National Meeting, Olympic Hotel, Seattle, Oct. 31-Nov. 5.

## NOVEMBER

- 68th Annual Meeting, Association of Military Surgeons of the U.S., Mayflower Hotel, Washington, D.C., Nov. 6-8.
- Special Technical Conference on Non-linear Magnetics, sponsored by IRE Professional Group on Electronic Computers, Professional Group on Industrial Electronics and the AIEE, Statler Hilton Hotel, Los Angeles, Nov. 6-8.
- Seventh Conference on Radio Interference Reduction and Electronic Compatibility, conducted by Armour Research Foundation and sponsored by Army, Air Force and Navy, Illinois Institute of Technology, Chicago, Nov. 7-9.
- Seventh Annual International Conference on Magnetism and Magnetic Materials, sponsored by IRE, AIEE, ONR and AIME, Westward Ho Hotel, Phoenix, Ariz., Nov. 13-16.
- Kansas City IRE, Symposium on Electronic Systems Reliability, Hotel Phillips, Nov. 14.
- National Society of Aerospace Materials and Process Engineers (SAMPE) Ceramics and Cermets, Bodies and Coating Symposium, Biltmore Hotel, Dayton, Ohio, Nov. 14-15.
- Northeast Research and Engineering Meeting, IRE, Somerset Hotel and Commonwealth Armory, Boston, Nov. 14-16.
- 19th Annual Aerospace Electrical Society Display, Pan Pacific Auditorium, Los Angeles, Nov. 15-17.
- First Conference on Medical and Biological Problems in Space Flight, Bahamas Conference, Nassau, Nov. 19-24.
- Electron Devices Meeting, IRE, Shoreham Hotel, Washington, D.C., Nov. 20-21.
- 11th Semiannual Meeting and Midyear Conference of the Manufacturing Chemists' Association, Inc., New York City, Nov. 21.
- ASME Winter Annual Meeting, Statler Hilton Hotel, New York City, Nov. 26-Dec. 1.

## A Tribute to the X-15

**D**AWN on the California desert comes cold and clear. Throughout the night, a small group of dedicated men have worked over a squat, ugly shape with the attention of a mother to a deformed child.

Other, sleepy-eyed men tumble out of cars and huddle on the flight line. The group disperses. Jets whine and the mothership climbs aloft with the ugly child tucked under one wing. Chase planes follow the pair in an anxious pursuit through the pale light.

Long minutes follow. The early morning sun glitters off the planes high in the air. Then a pencil-thin line of white vapor is drawn swiftly across the sky. The spacecraft streaks upward under the fierce thrust of its own rocket engines.

North American Aviation's *X-15* is reaching for another record in a performance becoming so routine that the tremendous achievements of the Air Force-NASA-Navy program are all too often taken for granted.

Within the past month, NASA test pilot Joseph Walker has flown the rocket craft to a speed of 3920 miles per hour—almost six times the speed of sound. Air Force Maj. Robert White has piloted the *X-15* to an altitude of 217,000 feet, more than 41 miles above the earth's surface.

In the light of these most recent accomplishments, it is perhaps time for a nod of industry recognition to the team which designed, built and is flying this first piloted U.S. spacecraft.

Judged on speed alone, the *X-15* is not far behind the *Mercury* capsule which carried Alan Shepard along a ballistic trajectory in his widely acclaimed space flight. The fact that the *X-15's* pilot is in full command of his craft during flight makes this accomplishment even more remarkable.

The *X-15* program got its start in early 1952, when NASA directed its laboratories to study the problems likely to be encountered in flight beyond the atmosphere. A decision followed in favor of a manned research spacecraft.

A team was assigned by NASA in 1954 to determine the characteristics of such a vehicle. Navy and Air Force, meanwhile, were carrying out similar studies. NASA's proposal was accepted as a joint effort.

Invitations to bid on the craft were issued in December, 1954. Bids in the design competition were evaluated in late 1955; North American won the contract in December of that year.

Less than three years later, the first *X-15* was rolled out and delivered to flight test. Its initial powered flight came in late 1959.

Since that time, first with the smaller engines and then with the big XLR-99 engine, the *X-15* has compiled a remarkable record of accomplishment, attaining an order of reliability which is extraordinary for a research project of this type.

The knowledge gained by the missile/space industry in advanced materials manufacturing, flight control design, rocket motor development, high-temperature stresses and human factors is a significant tribute to the *X-15* program.

**M**AJOR CREDIT for success of the program must go to North American. But more than 300 other firms share the credit.

The XLR-99 and XLR-11 rocket engines developed for the program by Thiokol's Reaction Motors division have played a large role in the success of the program—in an area which was pushing the state of the art.

General Electric developed the APU's; Garrett Corp. manufactured the liquid nitrogen cooling and pressurization system; David Clark Co. produced a new pressure suit for the program.

International Nickel Co. developed Inconel X to withstand the high temperatures. Bell Aircraft supplied the ballistic control rockets. Sperry Gyroscope developed an in-flight electronic indicator system; Lear produced a special three-axis indicator to show the attitude of the *X-15* in relation to the earth.

The grip for the control stick was manufactured in Van Nuys, Calif.; the electrical heating element for the nose probe came from Middletown, Conn.; a specialized voltmeter used for checking the electrical system was manufactured in Plainview, N.Y.; the explosive bolt used for separation of the lower vertical stabilizer before landing was produced in Hollister, Calif.

The human factors phase of the *X-15* program has been one of the most extensive in industry history. Even prior to flight testing, pilots and equipment were subjected to scores of tests in the USAF Aeromedical Laboratory at Wright-Patterson AFB. Maximum g forces were simulated in the Naval Air Development Center at Johnsville, Pa. Wind-blast tests were carried out on the sled track at Edwards AFB. Parachutes were tested at Navy facilities at El Centro, Calif.

The *X-15* program, initiated in early 1952, has cost somewhere in the neighborhood of \$120 million for three flight vehicles. There also have been large indirect costs.

The development program has extended across all phases of the missile/space industry and involved NASA, the Air Force and the Navy. Knowledge obtained from the *X-15* flights will be just as widely distributed.

We salute the men who designed and built the *X-15* and the pilots who have flown it. U.S. space-men for many years to come will owe them a great debt.

William J. Coughlin



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A knowledge of the detailed aerodynamic characteristics of a missile or aircraft is not required to apply GESAC to the vehicle. Thus, both flight testing and application engineering effort can be sharply reduced.

No external air data sensors or computers are required for gain changing.

GESAC has already been successfully flight-tested aboard the Convair F-106 under Navy Bureau of Weapons sponsorship. An evaluation of extremely rigorous re-entry profiles has been conducted on the North American/NASA X-15 Simulator under Air Force contract, with outstanding success. A flight evaluation on the McDonnell F4H-1 is currently in progress under Navy BuWeps contract. GESAC provides another example of Light Military Electronics Department leadership in aero/space electronics.

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A decisive move was made late in 1960: the first BMEWS (Ballistic Missile Early Warning System) radar station began operating at Thule, Greenland. This system keeps a 24-hour vigil against aggression by enemy ICBM's. Huge klystrons produced by Varian are the heart of the BMEWS transmitter sub-system. The powerful tubes generate radar signals—sent from antennas big as football fields—to seek out possible airborne intruders.

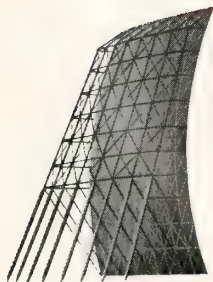
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NOVEMBER 6, 1961

# missiles and rockets

THE MISSILE / SPACE WEEKLY

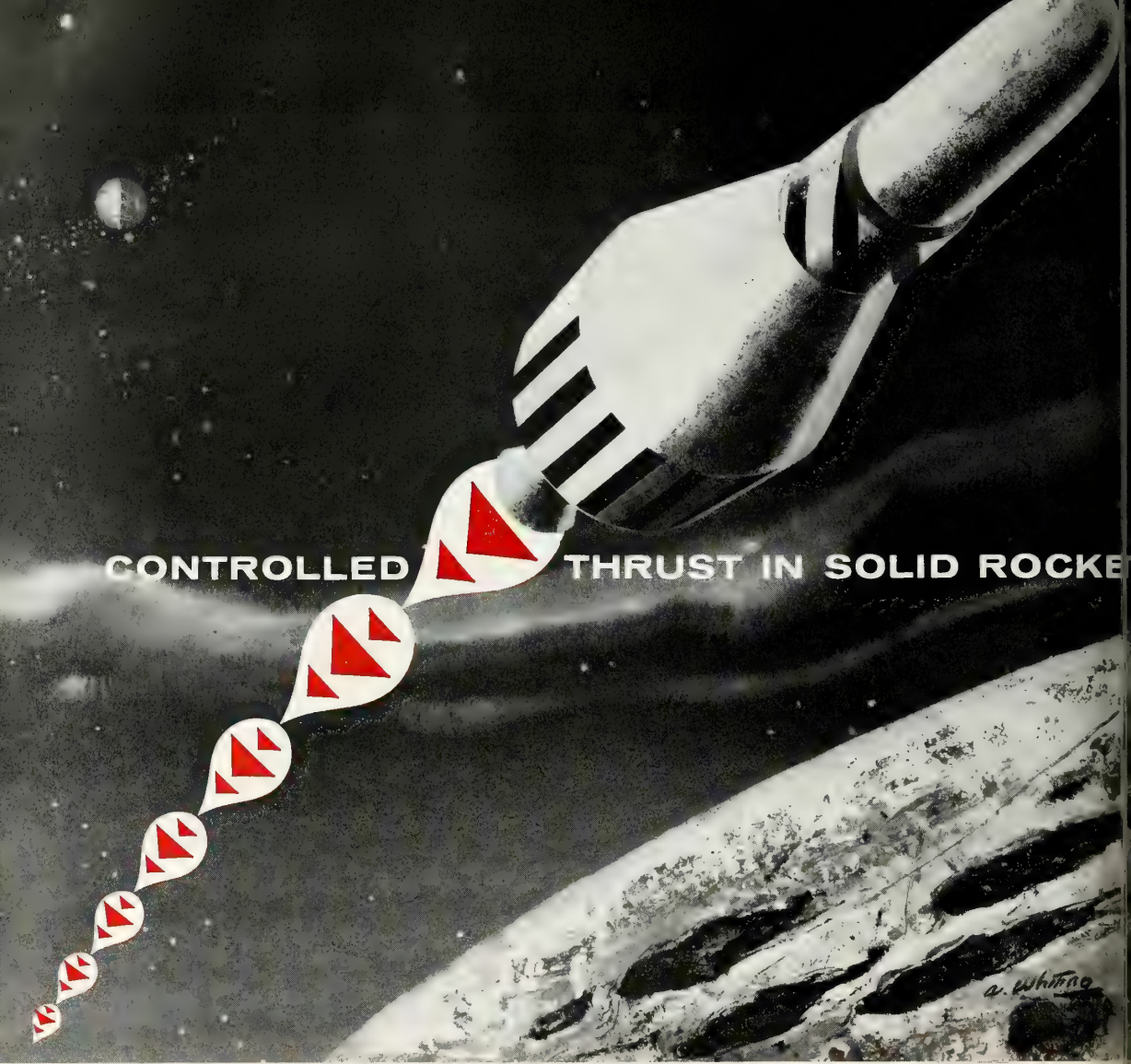


## NATO Arms Buildup: \$1 Billion Being Spent In U.S.

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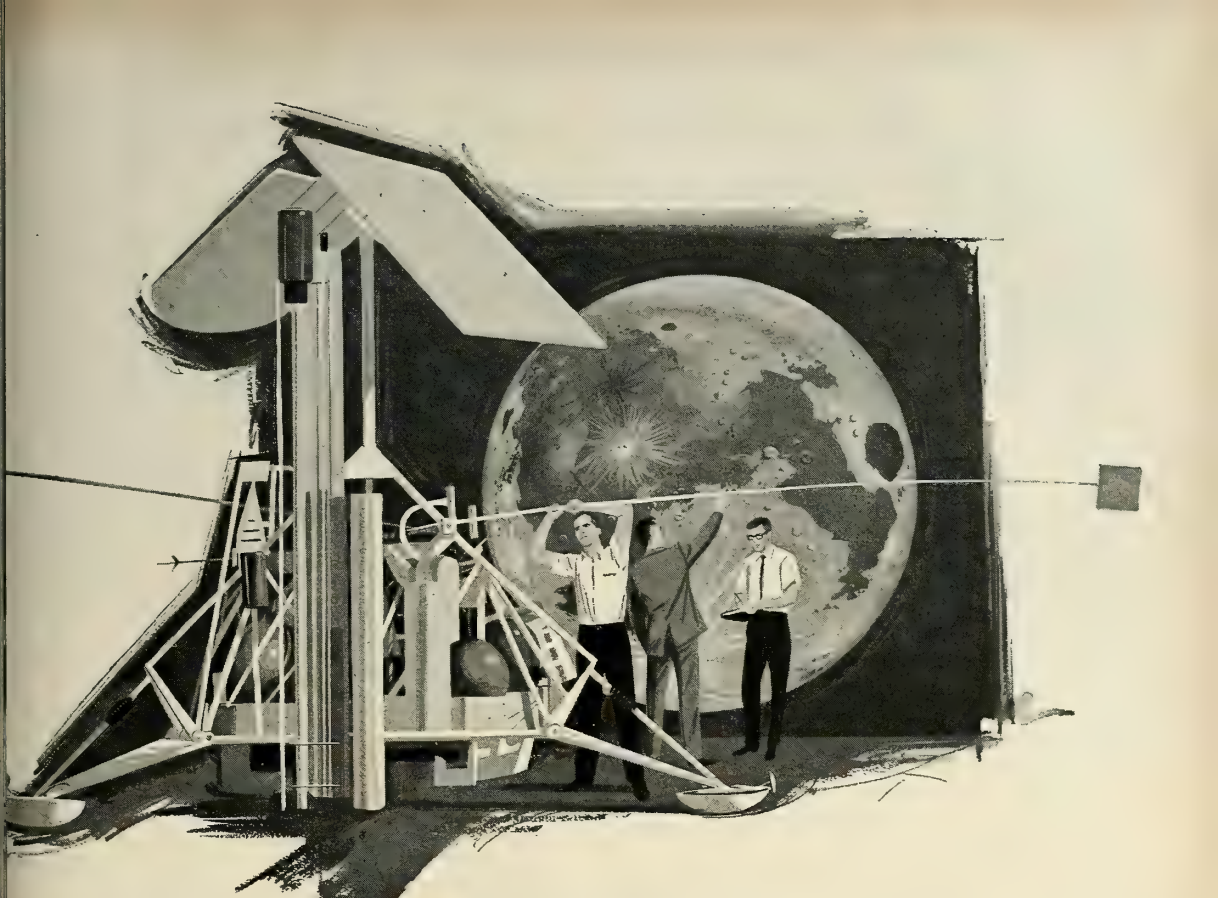
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# Sometime in 1963 Surveyor will land on the moon

Work on Project Surveyor, one of the most important in our nation's space program, is now underway at Hughes. It is an urgent, demanding project. The engineer or scientist who qualifies for a position on Project Surveyor will have opportunities for technical accomplishment and personal growth which are seldom offered.

At the same time, he will gain unique background which can insure his future in the expanding space fields.

Project Surveyor is just one of Hughes' efforts in space work. It involves the

design and development of a spacecraft which will "soft" land on the moon and gather, analyze and transmit back to earth information about the moon's surface, subsurface and atmosphere. Other Hughes space work includes: ARPAT (terminal anti-ballistic missile defense), BAMBI (anti-ballistic missile defense feasibility study), COLIDAR and SYNCOM (space communications systems), Space Propulsion Systems and Space Power Systems.

Hundreds of openings exist for imaginative junior and senior engineers and physicists. Experience is preferred, but not required. Representative openings include:

**CONTROLS ENGINEERS** Concerns hydraulics, airborne computers, and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, controls systems, control techniques, transistorized equalization networks and control servomechanisms.

**CIRCUIT DESIGNERS** Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

**SYSTEMS ANALYSTS** To consider such basic problems as: the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

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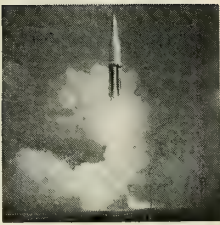
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## THE COVER

Saturn C-1 takes off on its first flight Oct. 27, proving out a multi-million-dollar U.S. gamble on clustered rocket principle. (See special report, pg. 16)

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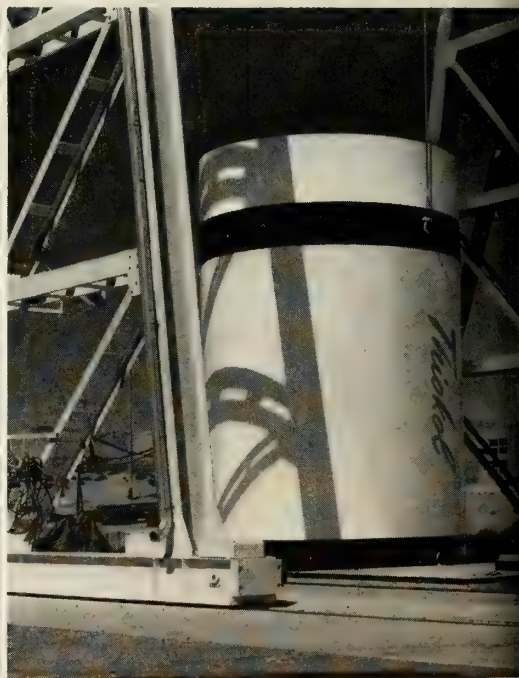
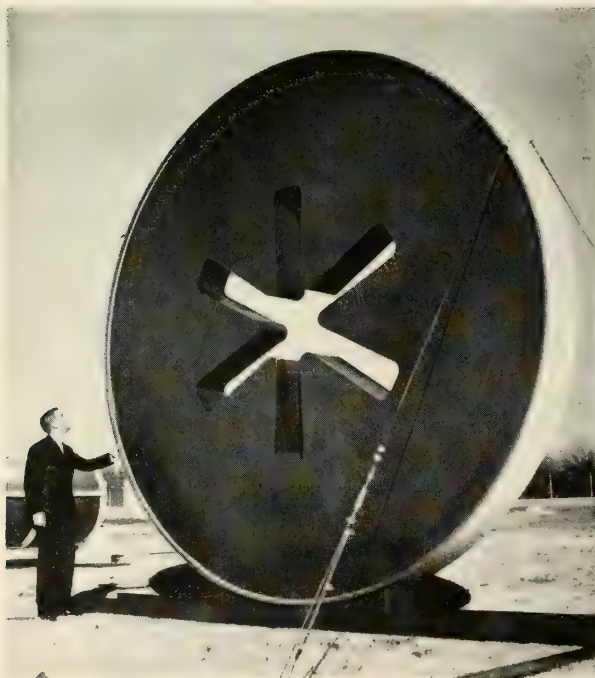
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†U.S. Reg. Pdg.

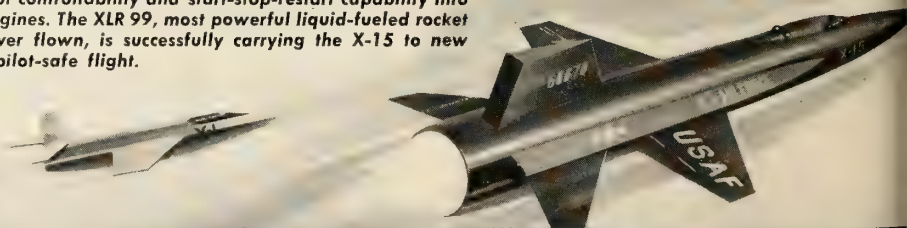
# **BENCHMARKS** in the science ...leading to power for lunar



**BUILDING THE BIG ONES.** Thiokol Divisions are now producing the most powerful and biggest solids ever flight tested in the world—first stages of Zeus and Minuteman. Available casting and curing pits, firing bays, handling, test and inspection equipment at these installations have space-engine capacity. These plants, as they presently exist, can support the immediate R&D necessary for an accelerated space booster program. Below: facility prototypes for the production of tomorrow's giant boosters.



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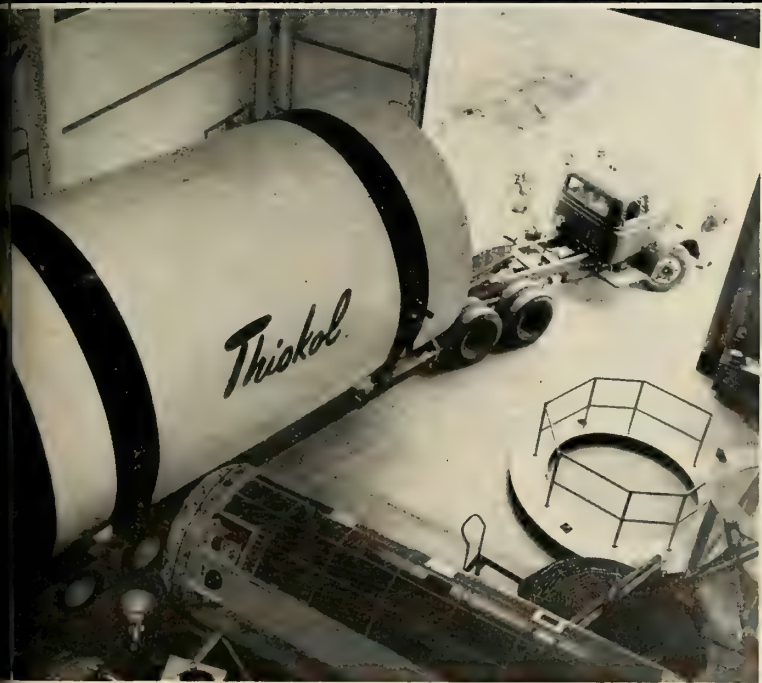
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# f rocket propulsion and planetary flight



**MAN-RATED, STOREABLE.** Retro rockets from Thiokol have been stored in space and successfully fired again and again. They have been used exclusively throughout the Apollo, Surveyor and Mercury programs, and have proven man-rated reliability by returning the astronauts safely to earth. Thiokol is now developing the retro rocket for the Surveyor lunar vehicle.



Today's propulsion technology lie answers to the challenge of manned space exploration. Thiokol has made many significant contributions to advancing the state of the art . . . has scored peak levels of reliability in engine performance, safety and cost. Working in cooperation with the military, government and industry, Thiokol developed the largest solid engines ever flight tested in the free world. Thiokol is the only man-rated rocket engines manufacturer, both solid and liquid. Thiokol's expertise in the design, and production of complete propulsion systems—engines, components, and fuels—its proven scientific engineering and managerial capabilities contribute to a firm base for America's next great step into space.

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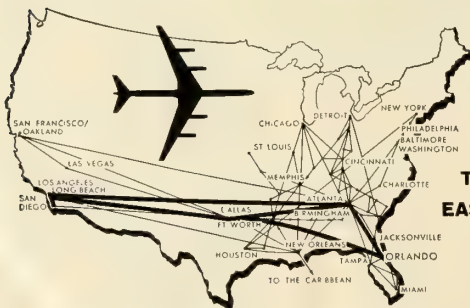
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## —letters—

### Setting Facets Straight

To the Editor:

In your article "First Details of Vel Hotel" (M/R, Oct. 23, p. 12), the description of an icosahedron as a "12-side package" is a contradiction in terms. A regular icosahedron is made up of 20 equilateral triangles, whereas a regular solid with 12 sides is a dodecahedron (its faces are 12 regular pentagons). The solid shown in the illustration appears to be 20-sided, i.e., an icosahedron. For further details see Euclid's *Elements*, Book XII.

Your statement that "this 12-side package will not necessarily be the operational shape" calls for a reminder from Euclid that the choice of regular solid, if the shape of one of these is desired, is rigidly limited. By successive proofs he showed that the five regular solids (pyramid, octahedron, cube, icosahedron, dodecahedron) can be inscribed in a sphere, and as a fillip he also proved that no other regular solids exist.

Joseph Horrell  
Vitro Laboratories  
Silver Spring, Md.

To the Editor:

The icosahedron—shown in the photograph accompanying your article—has twenty sides, each an equilateral triangle. The twelve-sided body is the dodecahedron, each side a regular pentagon—apt for military project, but not as much as the other for this purpose! I have an example of each type of body on my bookcase in my office, so I'm confident of my facts.

Paul L. Sowerby  
Secretary  
North West Branch  
British Interplanetary Society  
Manchester, England

To the Editor:

Is it a scientific breakthrough? A twelve-sided icosahedron?

Or, for the sake of security, are vertices being code-named "sides"?

If that is the case, the Enemy will certainly be confused by twenty-sided dodecahedrons!

Of course, they'll have us in a corner with regards to tetrahedrons. . . .

Stephen A. Kallis, Jr.  
Dunedin, Fla.

### Initials and Initiates

To the Editor:

For the past year it has been a pleasure to read MISSILES and ROCKETS. . . .

However, there is one suggestion I would like to make. Would it be possible to publish perhaps once a year a list of the abbreviations used throughout the year? For students or for that matter anybody else new in the field, it is quite often very hard to find the meaning of an abbreviation that for the "old guy" is plain everyday language.

August Graf  
Engineering-Science Student  
Hofstra College  
Hempstead, L.I., N.Y.

Suggestion noted.—Ed.



# The Countdown

## WASHINGTON

### Sergeant vs. Blue Water

The latest word on the Pentagon fight over continuing production of the Sperry *Sergeant* is that the alternative of buying the English Electric *Blue Water* is not involved in the considerations. The core of the dispute is whether *Sergeant* is needed—not whether a different missile should be procured. However, cutting off *Sergeant* by the Pentagon would leave the NATO market wide open to the British missile.

### More Saturns, Fewer Centaurs

The successful first flight of the *Saturn* C-1 is expected to result in a big switch in NASA vehicle plans. At present, 65 *Centaurs* are called for over the next eight years. But now NASA is considering a sharp reduction in the number in favor of more *Saturns*.

### Zeus and the Bubbling Political Pot

One of the essential considerations confronting the Kennedy Administration in deciding whether to order production of *Nike-Zeus* is the oncoming congressional election campaign in 1962. If the production order is shelved until next spring or later, *Zeus* backers in Congress are certain to make the lack of a U.S. missile defense system a meaty campaign issue.

### Bobbling the Dyna-Soar

The Administration refusal to spend the extra \$86 million that Congress voted for *Dyna-Soar* is considered a sharp set back to the development of military spacecraft. However, the Air Force is still hoping to reorient the *Dyna-Soar* program to accelerate it at least to some degree.

### Rocket Belts on the Gantries

Technicians working on the huge booster gantries now coming into use at Cape Canaveral may soon be equipped with rocket belts. The belts would enable the technicians to jump clear of a gantry in case of fire.

### Eagle Still May Fly

The *Eagle* air-to-air missile which the Kennedy Administration interred earlier this year is reported to be under consideration for possible resurrection. The Bendix missile would be deployed under the wings of the Navy's proposed new tactical fighter. Originally, *Eagle* was to be used in conjunction with a long endurance, relatively low speed aircraft—the now-defunct *Missileer*.

## INDUSTRY

### Bullpup Over AS-30

Martin's *Bullpup* appears to have won out over Nord's *AS-30* in the stiff competition for adoption by NATO

missiles and rockets, November 6, 1961

of an air-to-surface missile. One top official reports the *AS-30* failed to operate satisfactorily with the F-104 jet interceptor.

### Too Many Associations?

Some of the Pentagon's top civilian officials are understood to be taking a long look at the number of defense industry associations. Officials are contending privately and publicly that the number of associations appears to be excessive and that possible duplication is resulting in unnecessary costs.

### Big Business at the Cape

The NASA budget at Cape Canaveral during the next fiscal year will be about \$600 million according to current planning. Of this, about half is for the manned lunar landing program. Because of this boom at the Cape, NASA's Launch Operations Directorate may be taken away from the control of the Marshall Space Flight Center and placed directly under Associate Agency Administrator Robert Seamans.

### New Names To Note

Newly-merged Martin-Marietta has dropped the "The" from the name of The Martin Co., renamed the Cocoa Division the Canaveral Division and established an Electronics Systems and Products Division. Lockheed has renamed the Grand Central Rocket Co. the Lockheed Propulsion Co. Lockheed acquired full ownership of the company last August.

## INTERNATIONAL

### British Pleased with Sky Bolt Tests

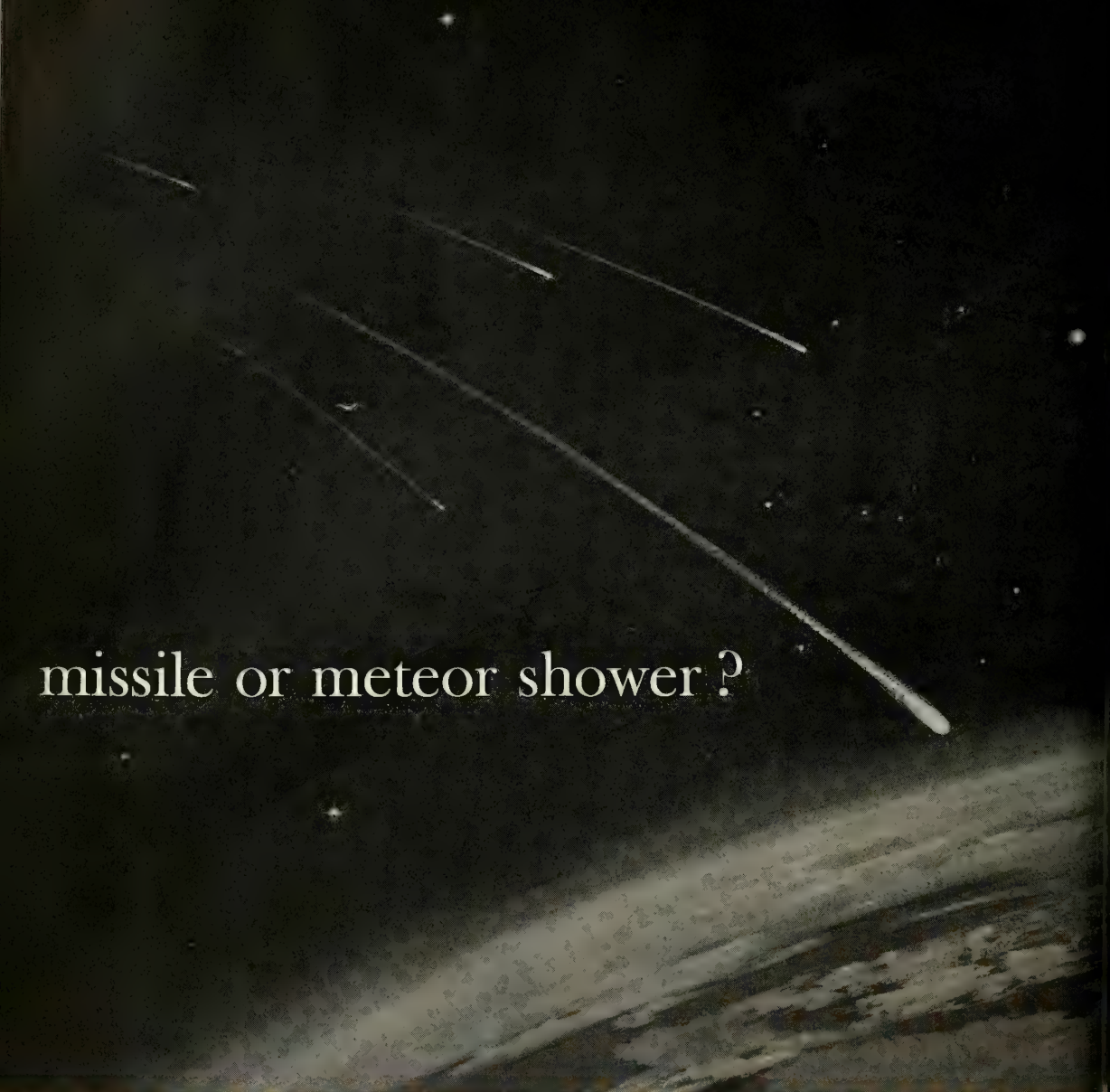
British officials are reported to be highly pleased with recent flight tests of inert Douglas *Sky Bolts* attached to a Vulcan bomber. The tests are understood to have involved both flying with and air-dropping the air-to-surface strategic missile. The RAF phase of the *Sky Bolt* program is scheduled to run about three months behind the SAC phase.

### Payroll Cuts at Hawker

Hawker-Siddeley has cut its 14-man Astronautics Division in half on grounds that the company has not received sufficient government support. A Hawker spokesman says the cuts will not stop at Hawker-Siddeley.

### COSPAR Names New Top Official

COSPAR has appointed Paul J. Beaulieu as its new executive secretary at its headquarters in the Hague. Beaulieu has been associated with Canada's National Research Council for the last six years. He will take over his new post Jan. 1.



# missile or meteor shower?

If it were a missile, the time for intercept would already be past.

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An essential part of any anti-missile defense system is an advanced multi-function, phased array radar-computer complex. This complex would permit the long range detection and selective tracking and labeling of vast numbers of space and re-entry objects—including satellites, space

vehicles, missile warheads and decoys. Needed is a radar system with beams which can be electronically steered in microseconds under the programming of an advanced computer. With such a radar it is possible to detect and track hun-

dreds of targets while continuing the search for additional threats. Because this type of radar antenna makes no mechanical motion, it can be easily hardened to withstand the heat and blast of a nearby nuclear explosion.

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# The Missile/Space Week

## Gilpatric Discloses FY '63 Budget Estimates

Deputy Defense Secretary Roswell Gilpatric publicly disclosed this week that Pentagon obligation for FY '63 would top \$50 billion.

Gilpatric estimated that missile procurement alone would rise from the current level of \$4.6 billion toward \$5 billion and that the total RDT&E budget would jump from \$7 billion to about \$8 billion.

The figure on missile procurement included ICBM's and some but not all tactical missiles. Among those systems included under a separate category were *Sidewinder* and *Bullpup*.

No firm figure for the FY '63 defense budget has been established to date. However, it is expected to total about \$52 billion.

Gilpatric spoke in Minneapolis at ceremonies dedicating Minneapolis-Honeywell Regulator Co.'s new Aeronautical Engineering Building.

## New Division at United

A Solid Rocket division is being established by United Aircraft Corp. to support its subsidiary, United Technology Corp. The new division in Coyote, Calif. will provide the nucleus of a future volume production facility in solid rockets.

## Space Heat Shifts

Compilations of data from Soviet and U.S. satellites show that temperatures 500 miles out in space fluctuate by as much as 1000°F. Results have been tabulated by COSPAR and are already being incorporated in satellite design.

The fluctuations depend on "day", "night" and distance from the sun. An increase in solar activity might increase the differential. The findings were reported at the National Academy of Sciences Autumn Meeting in Los Angeles.

## Helium Price Uped

The Bureau of Mines will raise the price of helium on Nov. 18 for the first time since 1954. The in-

crease, from \$19 to \$35 per thousand cubic ft., is to finance the Bureau's conservation program to prevent waste of 52 billion cubic feet of the irreplaceable gas.

## Moon Landing No Stunt

The moon is man's primer in studying the early matter of the solar system. NASA Director James E. Webb told the Aero Club of Washington that the lunar lack of atmosphere, wind and rain provides scientists with matter practically in the form it existed billions of years ago. This is one of the main scientific justifications for the U.S. Lunar Program.

## Shots of the Week. . .

- The first *Saturn* (SA-1) performed as programmed Oct. 27 in a launch from Cape Canaveral. The space booster reached an altitude of 84.8 miles and traveled 214.7 miles downrange.

- An attempt to test the *Mercury* tracking net failed Nov. 1 when the *Scout* launch vehicle veered off course and was destroyed 30 sec. after launch. The *Mercury-Scout* was to have carried a small "beacon" satellite into a 3-orbit test.

- A NASA *Nike-Cajun* was successfully fired from Wallops Island, Va. Oct. 27 in a test to measure electron density and temperature conditions in the nighttime ionosphere.

Telemetry reports from an earlier flight showed the presence of a narrow band of high electron density at an altitude of 63 miles, and having a thickness of only 2296 ft.

## Business Briefs

- Laboratory for Electronics stock holders approved the company's acquisition of Tracerlab, Inc. The merger became effective Nov. 1.

- Lionel Corp. and Hathaway Instruments, Inc. have merged. Lionel Corp.'s president, retired Maj. Gen. John B. Medaris, said after the merger his company sales will be about one-third toys and trains, one-third electronics and one-third "other forms of modern technology."

# NATO-U.S. Missile Boom Coming

More than 50 projects including Sidewinder 1-C  
Redeye and Mauler screened for possible NATO Production

by William E. Howard

PARIS—Spearheaded by the mutual production of *Hawk*, NATO nations today are moving into the manufacture of an array of advanced missiles and other weapons—most of them American.

This mounting defense effort already is resulting in an income to U.S. industry of more than \$1 billion and promises to grow substantially in the next few years.

Some 50 major projects presently are being screened by NATO technical committees; 20 of them are receiving serious consideration for production within the next several months.

The projects range all the way from VTOL aircraft to modern land and shipboard armaments. They include such missiles as the *Sidewinder 1-C*, *Redeye*, *Mauler*, an "economy" *Tartar*, *Sparrow III*, and the *HM* (for Hughes Missile) 55, a non-nuclear air-to-air

weapon resembling *Genie*.

These weapons are in addition to five already in varying stages of production:

—*Hawk* (primed in the U.S. by Raytheon Co.), being produced by France, West Germany, Belgium, the Netherlands and Italy and due for first flight at Colomb Bechar, North Africa, next year.

—Lockheed's missile-carrying F-104, being produced by Belgium, the Netherlands, Italy and West Germany.

—*Sidewinder* with Belgium, Denmark, Germany, Greece, the Netherlands, Norway, Portugal and Turkey participating.

—GE's *Mark 44* acoustic homing torpedo, initiated last April by France and Italy.

Moreover, NATO adoption of the *Martin Bullpup* is now almost a certainty. MISSILES AND ROCKETS has been told that the air-to-surface *Bullpup* has received the nod over France's compet-

ing *AS 30* because of the latter's reported incompatibility with the F-104 NATO fighter.

● **Quiet revolution**—All of this activity is the result of a quiet revolution that is rapidly gaining momentum in Europe, but has gone all but unnoticed amid the billowing of Russia's megaton smoke rings.

The revolution is a combination of many things. But primarily it is economic. European nations today have hard currency and they have a willingness to lay cash on the barrelhead to buy the know-how from U.S. companies to put themselves in the advanced weapons business.

The most significant breakthrough of all, however, is the dropping of ancient national commercial and political barriers which has opened the way for truly cooperative international projects.

For NATO as a whole this revolution is bringing about a rebuilding and modernizing of European defenses of a solidly-based domestic armaments industry. The main objective—planned and supported by the United States—is to put NATO for the first time since its inception on a self-sustaining basis.

This will still take several years. But providing there is no war, the chances for obtaining this objective and maintaining it for the long haul seem very good indeed, to U.S. defense planners.

"We're making real headway," says one official. "We've come a long way from the giveaway days after World War II. The money is now coming back to the U.S. side of the Atlantic while, at the same time, we are creating a much stronger defensive force in Europe."

Testimony submitted to Congress earlier this year shows that in the F-104 NATO program costing \$1.5 billion between \$800 and \$900 million is flowing back to U.S. industry.

In the \$700 million *Hawk* program more than \$125 million is destined to be spent in the U.S.; for the \$40 mil-



U.S. built *Hawks* that have been deployed in West Germany





← U.S. → ← RAYTHEON →

ROUNDTABLE conference at Raytheon shows manpower needed for Hawk management.

on NATO Sidewinder the U.S. industry share will be at least \$10 million. The addition of more projects of U.S. origin can only boost the total higher.

"Half-loaf" philosophy—All of this money is being spent on components, proprietary rights, license fees, engineering man hours, tooling—and in some cases even the outright purchase of "do-it-yourself" kits to allow European manufacturers to familiarize themselves with various weapon assemblies.

This is a far cry from the outright sale of a complete weapon system. And it has taken some "educating" on the part of U.S. defense officials to sell this concept to U.S. industry.

"It sounds like you are competing with yourself to hand over your trade secrets to a European company and set them up in business building your missile," says a Pentagon official.

"But the truth is they are dependent upon our industry for their know-how. We are really only selling them a half a loaf. If you sell a lot of half-loaves, you are still in the bakery business."

Although there is a great deal of friction and complaints over the sale of competing systems to NATO countries, chiefly between the U.S. and Britain, American defense officials are concerned only with equipping NATO with the best weapons available. They contend that most of the American missiles for NATO consideration are the best available. Hence, it is better to proceed in the "half-loaf" philosophy to make sure that they will buy the best.

While U.S. missile makers might prefer to sell whole systems outright, they, too, are said to have come around to the point of view that a half-loaf is better than none.

• **Hawk—the prototype**—The breakthrough in creating a consortium of European manufacturers to handle the production of an advanced missile system was scored with *Hawk*. This program, it is hoped, will be the prototype of similar international joint ventures.

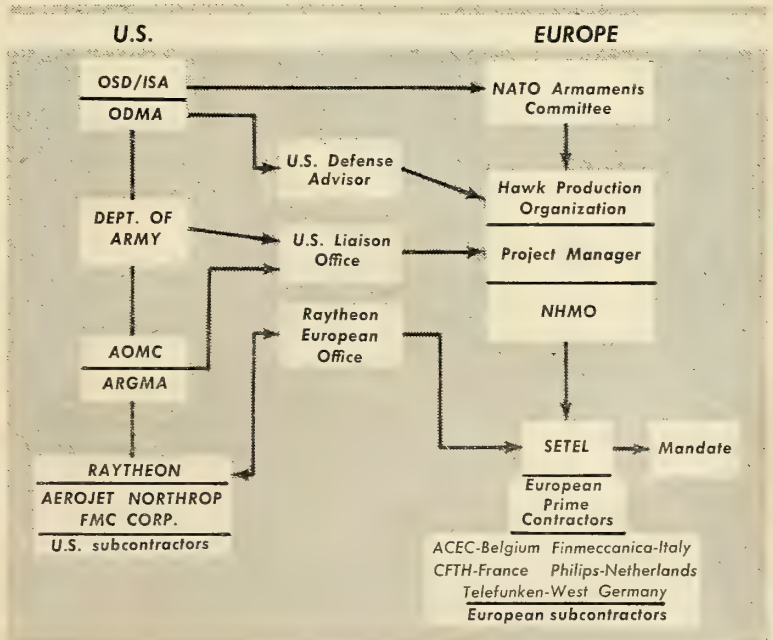
Started in the spring of 1959, the NATO *Hawk* organization headquarters here now expects to be turning out the first European produced missiles in the next few months. The program of 26 140-missile battalions is expected to take through 1965 to com-

plete. Estimates of the total cost, including follow-on improvements to the air-to-surface system, range from \$500 to \$700 million.

Originally, it was hoped that the program could be completed sooner. But various legal snarls and other unforeseen problems have cost about one year.

Nevertheless, officials of SETEL (Societe Europeane de Teleguidage) which is prime contracting the program feel they will still wind up with an extremely up-to-date missile and a

(Continued on page 38)



HOW U.S. channels production know-how into NATO Hawk. European production organization is run without U.S. vote.

# Red A-Tests Peril U.S. Deterrent

## Analysis of 28-Shot Series Indicates Russians Working For Anti-Polaris Missile, A-ICBM and Neutron Bomb

by James Baar

THE RECORD-smashing series of Soviet nuclear tests in the atmosphere is believed by many experts to have enabled the Russians to make major gains in developing nuclear weaponry.

Such gains—unless counteracted by the resumption of U.S. nuclear tests in the atmosphere—are expected to enable the Russians to undercut seriously the future effectiveness of U.S. strategic power.

For this reason, President Kennedy is considered to have little choice but to order the resumption of U.S. nuclear testing in Nevada and the Pacific

at the earliest possible date.

Some of the early inescapable conclusions being drawn from the now apparently-completed Soviet tests:

—The Russians appear to have been planning the 1961 tests series for at least a year. The extent of the series clearly discloses monumental Soviet duplicity in the East-West disarmament negotiations.

—The Soviet tests probably are based on secret underground tests conducted during the East-West moratorium.

—The Russians are developing a family of new smaller warheads for tactical and strategic missiles including anti-missile missiles and anti-Polaris sub weapons.

—The Russians probably made advances in the developing of new types of nuclear warheads such as the neutron bomb.

Besides gains such as these, the Russians are presumed to have made im-

portant nuclear effects tests involving hardened missile sites. Data from such tests will enable the Russians to refine considerably their missile targeting plans.

Although progress in many of these areas could be made in underground tests, further testing in the atmosphere eventually becomes essential. This may well have been the position the Russians found themselves in when they broke the three-year old moratorium Sept. 1 with the detonation of the first nuclear blast in the test series.

In all, the Russians conducted 28 tests reported by the AEC and undoubtedly conducted a number that were not reported. The total of 28 alone made the series the largest ever reported to have been conducted on either side of the Iron Curtain.

• **100 megs total** — Moreover, the Soviets were reported by the AEC to have detonated in the two-month period

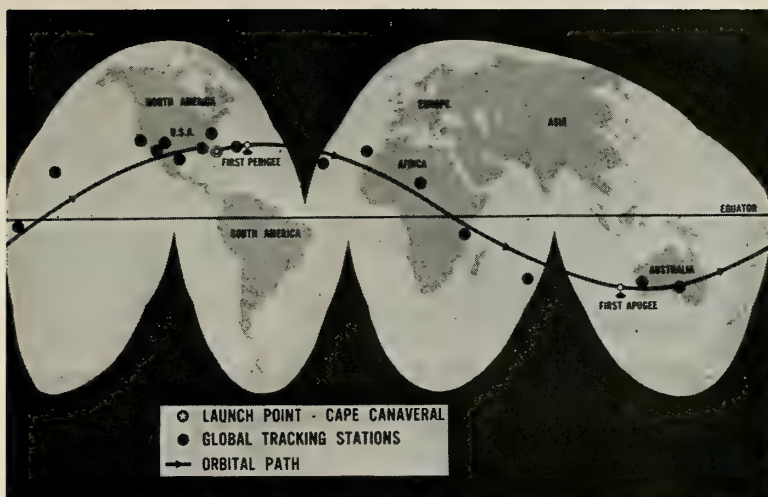
(Continued on page 44)

## Soviet 1961 Nuclear Warhead Test Series

| Number | Date     | Place                            | Type                                               | Number | Date     | Place              | Type                                               |
|--------|----------|----------------------------------|----------------------------------------------------|--------|----------|--------------------|----------------------------------------------------|
| 1      | Sept. 1  | Near Semipalatinsk in Kazakh     | Low to intermediate in the atmosphere              | 15     | Sept. 22 | Near Novaya Zemlya | About one megaton in the atmosphere                |
| 2      | Sept. 4  | Near Semipalatinsk               | About 20 kilotons in the atmosphere                | 16     | Oct. 2   | Near Novaya Zemlya | On the order of several megatons in the atmosphere |
| 3      | Sept. 5  | Near Semipalatinsk               | Low to intermediate in the atmosphere              | 17     | Oct. 4   | Near Novaya Zemlya | Several megatons in the atmosphere                 |
| 4      | Sept. 6  | East of Stalingrad               | Low to intermediate in the atmosphere              | 18     | Oct. 6   | Near Novaya Zemlya | Low yield in the atmosphere                        |
| 5      | Sept. 10 | Near Novaya Zemlya in the Arctic | Several megatons in the atmosphere                 | 19     | Oct. 8   | Near Novaya Zemlya | Low to intermediate yield in the atmosphere        |
| 6      | Sept. 10 | Near Novaya Zemlya               | Low to intermediate in the atmosphere              | 20     | Oct. 12  | Near Semipalatinsk | Several megatons in the atmosphere                 |
| 7      | Sept. 12 | Near Novaya Zemlya               | On the order of several megatons in the atmosphere | 21     | Oct. 20  | Near Novaya Zemlya | About 25 megatons in the atmosphere                |
| 8      | Sept. 13 | Near Semipalatinsk               | Low to intermediate in the atmosphere              | 22     | Oct. 23  | Near Novaya Zemlya | Low yield underwater and in the atmosphere         |
| 9      | Sept. 13 | Near Novaya Zemlya               | Low to intermediate in the atmosphere              | 23     | Oct. 23  | Near Novaya Zemlya | Less than one megaton in the atmosphere            |
| 10     | Sept. 14 | Near Novaya Zemlya               | Several megatons in the atmosphere                 | 24     | Oct. 25  | Near Novaya Zemlya | Low to intermediate yield in the atmosphere        |
| 11     | Sept. 16 | Near Novaya Zemlya               | On the order of a megaton in the atmosphere        | 25     | Oct. 27  | Near Novaya Zemlya | About 50 megatons in the atmosphere                |
| 12     | Sept. 17 | Near Semipalatinsk               | Intermediate yield in the atmosphere               | 26     | Oct. 30  | Near Novaya Zemlya | Several megatons in the atmosphere                 |
| 13     | Sept. 18 | Near Novaya Zemlya               | About one megaton in the atmosphere                | 27     | Oct. 31  | Near Novaya Zemlya | Intermediate to high yield in the atmosphere       |
| 14     | Sept. 20 | Near Novaya Zemlya               | About one megaton in the atmosphere                | 28     | Oct. 31  | Near Novaya Zemlya |                                                    |



# Mercury Tracking Net Checkout Fails



PROGRAMED orbital flight path for ill-fated Mercury-Scout capsule.

NASA plans to check out the readiness of the Mercury worldwide tracking network with a small cigar-shaped satellite have apparently been dropped with the failure of the first launching attempt.

The Scout booster carrying the satellite was deliberately destroyed in flight Nov. 1 after a guidance problem developed seconds after the rocket left Cape Canaveral launching pad.

Launching of the satellite was the next to the last big step before NASA attempts to put a manned Mercury capsule in orbit, possibly late this year.

The only other major step is the launching into orbit later this month of a simian-carrying Mercury capsule.

The 150-pound check-out satellite is scheduled to be launched into an orbit with an apogee of about 400 miles.

The satellite was designed to broadcast signals to the Mercury net for three complete orbits and then to be shut down by ground command while flight data is studied.

A ground command could reactivate the satellite and again shut it down as many as four times if necessary. No attempt was to be made to recover the satellite.

Besides testing the tracking-net, the first-called Mercury-Scout I—was also to check the real-time orbital computing facilities at the Goddard Space Flight Center in Greenbelt, Md., and the communications link between Goddard and the Mercury range stations.

The satellite's payload was provided by McDonnell Aircraft. It included UHF and S-band radar beacons, two telemetry transmitters, two command receivers, two minitrack beacons and a standard Mercury battery.



MERCURY-SCOUT being raised into position for firing at Cape Canaveral.

## Saturn C-1 Production

**First flight proving clustered booster means C-1 likely to get 'workhorse' role; 50 may be built. Chances seem small for program speedup; second stage engine tieup lagging**

by Hal Taylor

CAPE CANAVERAL—Proof of the cluster principle in *Saturn's* first flight is expected to bring about a future heavy reliance on this form of space booster.

Following the Oct. 27 flight of the *Saturn* C-1 to an altitude of 84.8 mi. and 215 mi. downrange:

—A high NASA official predicted the C-1 will become the "workhorse" of the U.S. space program, at least 50 will be built, and that the total worth of the C-1 industrial production contract could hit \$2 billion.

—A top level NASA-DOD committee moved closer to completion of its report which will call for primary reliance on orbital rendezvous, the *Saturn* C-4 and nuclear energy upper stages for achieving a manned lunar landing. Development of a large *Nova* vehicle will continue on parallel lines but at a slower rate. Contracts for the large vehicle are not expected to be awarded until late next year.

—Marshall Space flight Center officials said that SA-2—the second completed C-1 first stage—has completed its static test firings. It will now undergo two months of checkout and the installation of some electronic equipment. It will then be shipped to Cape Canaveral to meet its March 1962 launch date.

—Dr. Werhner von Braun declared that development of the *Saturn* C-1 can not be speeded—at this time—because of the development schedule for its RL-10 engine second stage.

—Top space agency officials declared that the C-1 is the world's largest known space booster and that the Soviet

Union's biggest vehicle with a thrust of 800,000 lbs. could not have lifted it off its pad.

• **Early cutoff**—The claim of supremacy for U.S. space booster came at a press conference following the 8 minute 3.6 second flight of the C-1 which space agency officials said was "completely successful." While the *Saturn's* performance was slightly under the planned 95 mile altitude and 220 mile range, officials said this was caused by a slightly early cutoff in the engines. They also pointed out that not once during the long countdown was there any "hold" for technical reasons. For the first flight, only the eight-H-1 engine first stage was live, the two upper stages were dummies with water used as ballast.

Maximum velocity was 3607 miles per hour. The vehicle's four inboard engines burned for 109.37 seconds, whereas the four outboard engines burned 115.15 seconds.

The period of holddown on the launch pedestal—from the moment of initial ignition to liftoff—was 3.97 seconds. The engines were ignited in pairs requiring a total of 3/10's of a second.

Final weight of the rocket at liftoff was 927,000 lbs. Thrust achieved at liftoff was 1.296 million lbs. The maximum thrust at altitude—which occurred just before cutoff, was 1.515 million lbs.

The success of the flight prompted one NASA official to declare that the C-1 would become a workhorse in preliminary flights of the *Apollo* program, communication satellites, and deep space probes. He estimated that at least 50 would be built. Total cost of the first 10 developmental flights is set at \$800 million or an average of \$80 mil-



# Contract May Soar to \$2 Billion

on each. While these costs will undoubtedly be cut when U.S. industry takes over production of the C-1, a contract for 40 of the vehicles would be worth about \$2 billion.

Seven firms are competing for the contract—Chrysler, Boeing, Lingemco-Vought, Ford Aeronutronic, Avco, Northrop, and Lockheed—which will be signed in December.

The joint NASA-DOD committee report on the U.S. space program requirements was due November 6. It is likely, however, that it may be delayed for a short time.

- **C-4 for rendezvous**—It has been learned that the committee will recommend that NASA develop the *Saturn* C-4 vehicle—with a first stage of four F-1 engines—developing a thrust of 6 million lbs.—for use in orbital space rendezvous flights.

A so-called C-5 with five F-1 engines—which would be the first *Nova* class vehicle—would be developed only the weight of the *Apollo* spacecraft increased.

NASA officials believe that the C-4 could do the logistics job for a manned lunar landing which calls for putting 100,000 lbs. in earth orbit, 180,000 lbs. to escape velocity, 50,000 lbs. landed on the moon and a return payload of 13,000 lbs.

Using orbital rendezvous—which calls for the joining of space vehicles while in orbit—the C-4 could accomplish this in two flights. With nuclear upper stages, it could take a payload to the moon in direct-flight which would provide a return payload of 17,000 lbs. This is well within NASA plans for a return payload of 30,000 lbs.

While the so-called "Golovin" committee will also call for parallel development of the big *Nova* booster for direct flights to the moon, space agency officials now only regard it as a backup to be used if the "rendezvous" concept proves impractical.

## Two firms to build Saturn stages

*Production of both the S-1 and S-1b stages of the Saturn launch vehicle will take place simultaneously at the Michoud, La. plant.*

NASA officials say that the contract for production of the 8-H-1-Engine S-1 first stage, successfully launched on October 27, will be signed in December. It is hoped, the officials said, that the firm awarded the contract will be moved into the plant and ready to operate by next March with the first completed vehicles to roll off the assembly line by late 1963.

Another firm will be awarded the contract for the S-1B stage which will have two or more F-1 engines. Best bet now is for a four-engine version developing a total first stage thrust of 6 million lbs.

Bids on this stage are due on November 8. While the award of this contract will be delayed slightly, the officials said that eventually, the two firms will be producing the boosters side by side at the same time. The first S-1B stages are expected to be ready for flight testing in the 1964-65 period.

To manage this very complex setup, the Marshall Space Flight Center will set up its own management office at Michoud which will have a staff of about 25.

- **Mate in space**—NASA officials will kick off intensive study of the rendezvous concept with a test program next year which will attempt to mate a *Mercury* capsule with an *Agena B* rocket while in low earth orbit.

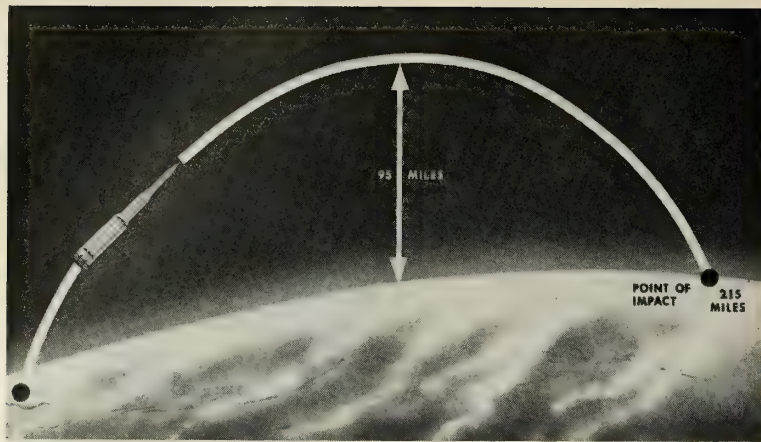
It is firmly believed that this concept can cut as much as two years off the target date for a manned lunar landing, making a 1967 goal fairly certain. Under the present schedule, a *Saturn* C-4 first stage could be ready for a test flight in late 1964 or early 1965. NASA Launch Operations Directorate is also pushing the formulation of plans for launch complex 39 at Cape Canaveral which will be used for rendezvous flights. This will have a large vertical assembly building capable of preparing 6 to 8 C-4's. The complex with three pads will be able to launch 25 flights a year.

The committee has also approved an AF request to build a 120 in. solid rocket motor. Each segment of the motor would have a thrust of 200,000 lbs.

Under one plan, the segments would be grouped around a *Titan II* liquid powered booster. The vehicle would be used to launch orbital versions of the *Dyna-Soar* winged manned spacecraft if enlarged for orbital flights.

The new vehicle—which has been dubbed the *Titan III*—could also be used to put the *Advent* communications satellite into a 22,500 mile-high orbit. Another possible use would be as a booster for space rendezvous experiments and DOD programs. It is expected that total development of the motor will cost several million dollars.

The committee is also considering a 160 in. solid rocket motor which would be built by the Air Force to NASA specifications. The engine would have five 20 ft. segments with a total weight of 1.3 million lbs. and a total thrust of 3 million lbs. No firm decision has been made between this motor and a 240 in. solid motor which would develop 5 million lbs. thrust. Both engines are intended as a solid



**EARLY ENGINE** cutoff during Saturn's Oct. 27 flight resulted in slightly lower and shorter distance than programed, but still "completely successful" shot.

backup for the liquid propelled *Nova* vehicles which are planned.

While the Golovin committee moved ahead with its plans for future generation space vehicles, there was disquieting news at Cape Canaveral concerning the inability to speed development of the *Saturn* C-1 vehicle.

• **Live second stage**—Under the present schedule, two more shots with a live first stage and dummy upper stages will be made next year. In 1963, five flights will be made including SA-1 which will be the first with a live second stage.

Dr. Wernher Von Braun indicated that a speedup in the development of the *Saturn* is almost precluded by difficulties in the development of its second stage which will have six R-10 liquid hydrogen-liquid oxygen powered engines which will develop a total stage thrust of 90,000 lbs. This is the same engine which has delayed development of NASA's *Centaur* Launch Vehicle.

The German-born rocket scientist said that "We cannot possibly accelerate the second stage so that it can be fired any sooner. On the other hand, there is no point in firing more than four single-stage flights alone, in other words,

without the second stage. For that reason, any speedup in the launch operation of flight two, three and four would not accelerate the launching of number five which is the first to fly a live second stage."

Von Braun said that the real problem is that the engine incorporates brand new technology but that progress has been made.

It has also been learned that a multitude of proposals have been made by NASA officials and industry for the scrapping of the RL-10 engine second stage and its replacement by other configurations.

• **Table thumping**—Dr. Seamans, at a meeting approximately six weeks ago, literally slammed his fist on the desk and told a launch vehicle personnel to stick with the stage and get it developed on time. Some real answers on the development of the stage will be forthcoming in January when the first *Centaur* vehicle utilizing two of the engines will be launched.

The H-1 engines for the first four developmental flights will have a thrust of only 165,000 lbs.; for later flights they will have an individual thrust of 188,000 lbs. for a total stage thrust of

1.5 million lbs. The two-stage *Saturn* C-1 will be capable of placing a payload of about 20,000 lbs. in low earth orbit. On advanced three stage configurations, it will be able to place 80,000 lbs. in low earth orbit, send 30,000 lbs. to escape velocity or 20,000 lbs. on Mars or Venus probes.

The H-1 engine is an advanced and compact offspring of the *Jupiter* and *Thor* engine. Major changes incorporated in it include a simplified start sequence using a solid-propellant gas generator and location of the turbo pump on the thrust chamber, below the gimbal block, so that the flexible propellant feed lines to the engine need only carry low pressure propellant.

The eight engines are attached to an eight-legged thrust frame on the aft end of the vehicle and arranged in two square patterns, the four inboard engines are rigidly attached and canted at a three-degree angle to the long axis of the booster. The outboard engines are canted at an angle of 6 degrees and mounted on gimbals which permit them to be turned through angles of up to  $7\frac{1}{2}^\circ$  to provide control of the vehicle during first stage powered flight.

Clustered in a circle about a large 105-in.-dia. center tank are eight smaller tanks each 70 inches in diameter. The four outer tanks and the center tank contain liquid oxygen, while the remaining four outer ones carry the kerosene fuel.

The fuel containers are pressurized by gaseous nitrogen carried in 48 fiber glass spheres atop the tanks, and the liquid oxygen containers are pressurized by gaseous oxygen obtained by passing liquid oxygen through heat exchangers that are part of each engine package. SA-2—the second *Saturn* vehicle—is scheduled to be launched in March 1962. Static test firings at Marshall have just been completed. It will now undergo about two months of checking before shipment to Cape Canaveral. Tankage for SA-3, 4 and 5 has also been completed.

## New NASA Cape Office

NASA's Launch Operations Directorate is setting up a brand new procurement office which will be responsible for dispensing hundreds of millions of dollars for launch facilities and ground support equipment.

First big job of the new office is to contract for some \$30 million of GSE for launch complex 37 which will have a service tower and two launch pads for the expanded C-1 flight operations.

Procurement for launch complex 39 which will be used in the U.S. Apollo program will also begin early next year and will go into high gear in fiscal 1963. It is estimated that the complex which will have a giant assembly building and three launch pads for multi-million-lb.-thrust launch vehicles

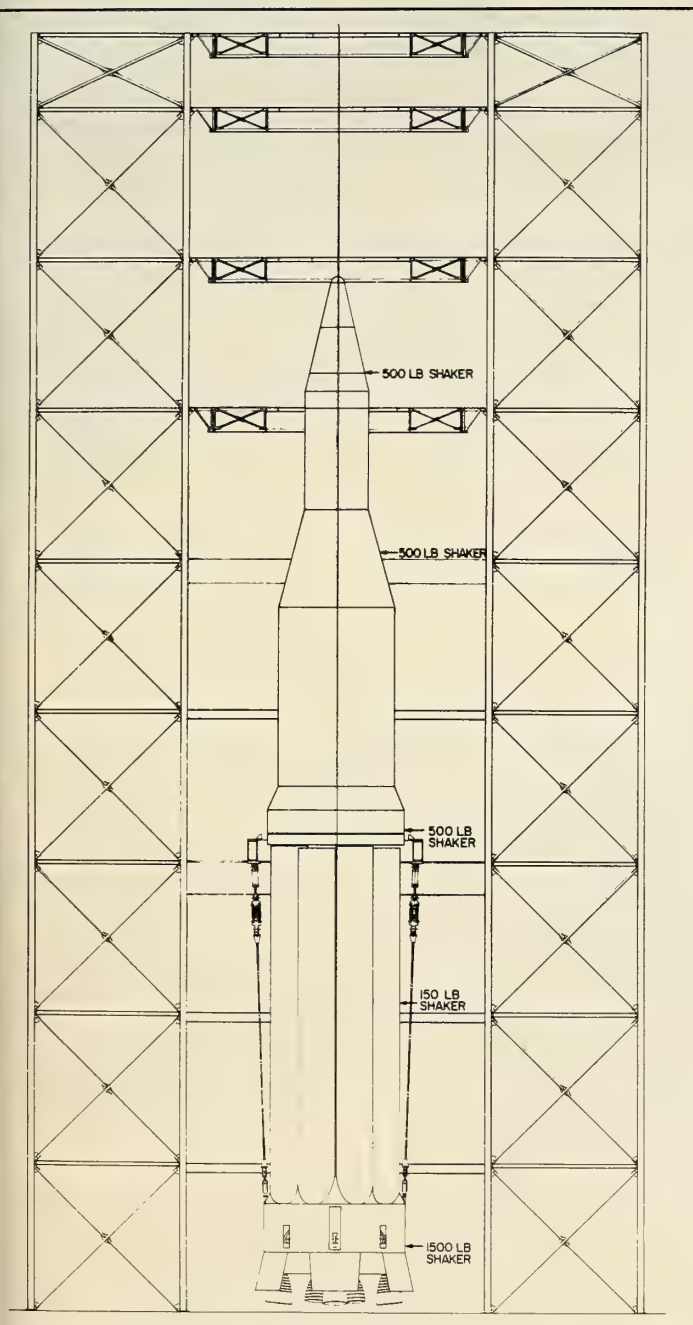
will cost some \$500 million.

Previously, all of NASA's Cape Canaveral Procurement was handled by the George C. Marshall Space Flight Center in Huntsville, Ala. Under the new setup, procurement authority has been delegated to LOD. Its new purchasing office will begin operation on January 1, 1962.

LOD's new procurement authority will generally be the same as that of Marshall's. It will be able to award single contracts worth up to \$10 million in the *Saturn* program \$1 million in R & D contracts and up to \$250,000 in facility procurement. Construction contracts at Cape Canaveral will continue to be handled by the Army Corps. of Engineers, Jacksonville, Fla. district.



# Vibration Tests Aided First Flight



AN EXTENSIVE—but still experimental—vibration test program contributed to the first successful flight of the *Saturn* booster.

Started in a huge static facility, the accumulation of data on the behavior of the eight-engine rocket cluster is being continued through the first five *Saturn* flights.

By then, engineers of the Marshall Space Flight Center's Structures and Mechanics Division in Huntsville, Ala., believe they will not only have proved the vehicle's structural soundness but gained sufficient data for the design of control system components and networks.

Test program objectives and procedures were spelled out in a series of papers presented by program engineers at a recent Symposium on shock vibration and environment. They tell how, without being able to rely on past experience of vibrational problems with large rocket clusters, the engineers designed a comprehensive program to determine *Saturn*'s lateral and torsional bending modes.

**• Static Test Vehicle Used—**To simulate as closely as possible the characteristics of the *Saturn*, a full scale prototype of the first flight test vehicle—designated the *Saturn* Dynamic Test Vehicle (SA-D)—was used. The vehicle consisted of the 75-foot booster with its clustered tanks and engines and the water-ballasted, dummy S-IV and S-V stages.

In the forward portion of the space vehicle, an instrument compartment and dummy payload were added—making the static test vehicle completely analogous to the flight model, both in length and in weight.

To achieve a free-free condition, the vehicle was suspended in the dynamic test stand shown below. This suspension system consisted of cables running from outrigger points in the tail section of the vehicle through a group of springs to a hydraulic cylinder fastened at the 72 ft. level of the tower.

To raise the vehicle clear of its hold-down structure approximately 1¼ inches, eight hydraulic cylinders were used. The springs present in each support cable provided a relatively soft suspension system with a total maximum lateral spring rate of 560 lbs. per

CRITICAL measuring and data accumulation points of the *Saturn* static test facility are shown in this line drawing.

in. and a total vertical spring rate of 560,000 lbs. per in.

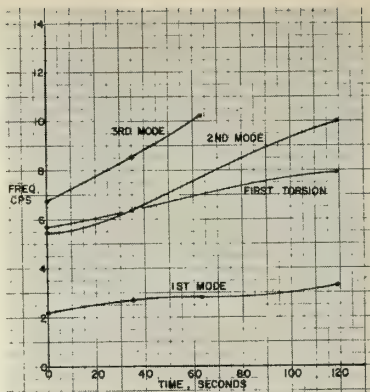
A parallel study—made of the vehicle suspended in the test tower—showed that the suspended vehicle's bending frequencies exceeded the free-free frequencies by 12% for the first mode, 6% for the second and considerably less for the third and fourth modes. This analysis enabled engineers to determine analytically the boundary conditions that would alter the free-free bending vibrations because of the suspension system.

• **Test Objectives**—The purpose of the experimental vibration program was to excite the vehicle through a frequency range sufficient to determine the significant free-free lateral, torsional and longitudinal mode shapes, frequencies and associated damping coefficients. To accomplish this, four flight conditions were tested:

- T equals Zero (Lift-off)
- T equals 35 secs.
- T equals 63 secs. (Q max.)
- T equals 119 secs. (cut-off)

Since the instrumentation used on previous vibration tests had a natural frequency of 6 cps, it could not be used on these tests where the frequency range would be from 0-10 cps. Therefore, strain gage bridge type, lg, accelerometers were used. The magnitude of the vibration measuring program is illustrated by the fact that, over the course of 23 static firings, 1605 measurements were made at 388 different locations.

A system of four shakers was used to determine the lateral and torsional mode shapes. Each new time condition was investigated using two or three



LATERAL and torsional bending frequency variation with increasing flight time.

shakers and by varying the phase of the shakers, mode shapes were established. These original mode shape studies were followed by transfer function determinations with the 1500 lb. shaker—located at the gimbal plane—being operated alone at force levels between 1000 and 1500 lbs.

Power to drive the shakers was supplied from a 40-ampere amplidyne generator modified to deliver constant current. An increased response time for operation in the frequency range of 0-15 cps and an electronic power amplifier for use above 15 cps were essential elements of the power generation equipment.

• **Test Results**—In general, the primary mode shapes are considerably affected by coupling of the outer tanks with the vehicle—particularly their indi-

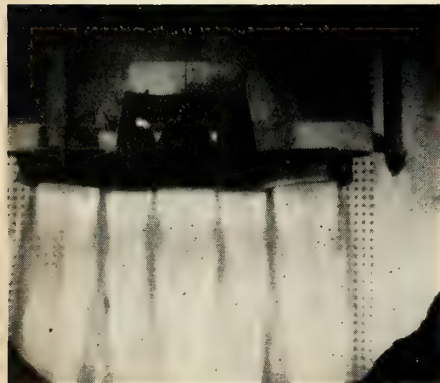
vidual resonant frequencies occur near one another. For example, at the Qmax and cut-off conditions second and third modes, the clear vehicle modes are obscured by coupling and interaction between the central and outer propellant tanks.

During the tests, the lateral bending mode frequencies increased from 2.18 cps at the lift-off first mode to almost 12 cps at the cut-off third mode.

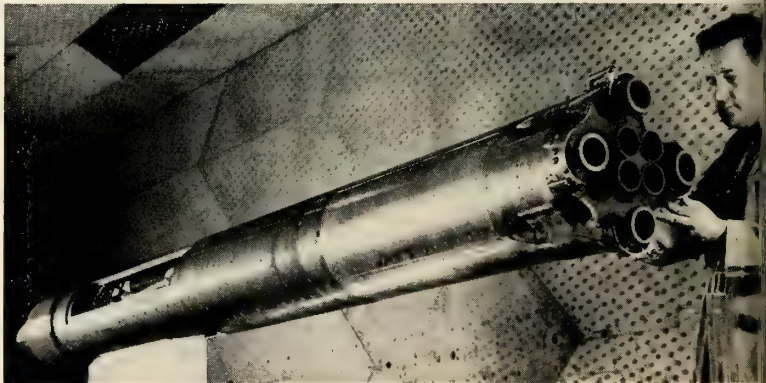
Structural damping factors—determined experimentally—showed that damping increases with increase in vehicle fullness and decreases with increased bending mode. Also fluid movement (sloshing) generally appeared to increase damping with the exception of the third mode at lift-off which showed a low damping factor.

• **Flight Vehicle Instrumentation**—Although the comprehensive static test program outlined has yielded important data on the vibration characteristics of the Saturn, further measurements will be made on the first five flight vehicles. In fact, an average of 60 measurements per flight are planned for the five vehicles. And, on the Saturn's fourth flight, approximately 89% of the telemetry data will consist of vibration information.

These measurements will provide the information needed for the design of the vehicle components as well as data required to write meaningful specifications. However, probably the greatest benefit of the vibration test program is the experience gained in the problems inherent in clustering engines for space vehicles.



WIND tunnel firing closeup.



SATURN model readied for test at Arnold Engineering Center.

## Scale Model Saturn Gets High Altitude Checkout

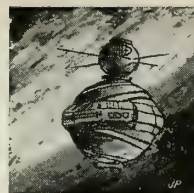
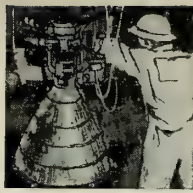
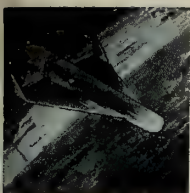
HIGH-ALTITUDE simulation tests at the Air Force's Arnold Engineering Development Center helped determine the extent of Saturn reentry heating.

Under conditions simulating speeds of Mach 3 and an altitude of 80,000 ft., engineers were able to determine the amount of base heating as the booster passes through the earth's atmosphere and the best means of preventing high-temperature damage to the booster.

A 1/20th-scale model of the booster was used for the tests as shown in the picture at right. A frame from a high-speed motion picture film (left) shows the Saturn model being fired in the high-altitude tests cell.

In other tests at Arnold, the flight characteristics of the space booster were investigated. The work was done by the Air Force test center under the auspices of NASA's Marshall Space Flight Center—developers of the Saturn.





NOVEMBER, 1961

## MISSILES and ROCKETS

# ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



## Missiles and Rockets

| PROJECT                  | CONTRACTORS                                                                                                     | DESCRIPTION                                                                                                                                                                                                              | STATUS                                                                                                                                                                                                      |
|--------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ALFA (Navy)              | Navy, prime; Avco, air frame                                                                                    | ASW surface-to-underwater; 500 lb. solid; conventional                                                                                                                                                                   | Deployed on destroyer escorts                                                                                                                                                                               |
| ASROC (Navy)             | Minneapolis-Honeywell, prime; Sanguamo Electric, sonar; torpedo, GE; depth charge, M-H; Librascope fire control | Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D                                                           | Operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers                                                                                          |
| ★ASTOR (Navy)            | Westinghouse, prime                                                                                             | ASW underwater to underwater wire-guided torpedo; nuclear                                                                                                                                                                | Operational                                                                                                                                                                                                 |
| ★ATLAS (Air Force)       | GD/Astronautics, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle         | ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability | 99 launchings; 66 successes, 21 partial, 12 failures; 11 bases for 13 squadrons; operational at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 45 launchers operational, about 54 by year's end |
| BOMARC-A (Air Force)     | Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion                                        | Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear                                                                                                                                       | Five bases operational in Northeastern U.S. from Virginia to Maine                                                                                                                                          |
| BOMARC-B (Air Force)     | Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion                               | Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear                                                                                                                                         | Operational; a B test bird intercepted simulated target 345 miles away Oct. 14, 1960; being deployed at six U.S. bases, two in Canada                                                                       |
| BULLPUP (Navy-Air Force) | Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime       | Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)                    | Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters                                                        |
| COBRA (Navy)             | No contract announced                                                                                           | Anti-ship radar missile                                                                                                                                                                                                  | Early R&D                                                                                                                                                                                                   |
| COBRA (Marines)          | Boelkow Entwicklungen, West Germany, prime manufacturer; Daystrom, U.S. licensee                                | 20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant                                                                                                                                              | Marines planning to purchase; Army considering them; already operational with West German troops                                                                                                            |
| CORPORAL (Army)          | Firestone, prime; Gilfillan, guidance; Ryan, propulsion                                                         | Surface - to - surface; 75-mile range; liquid; nuclear                                                                                                                                                                   | Deployed with U.S. & NATO troops in Europe                                                                                                                                                                  |
| CROW (Navy)              | No contract announced                                                                                           | Air-to-air missile                                                                                                                                                                                                       | R&D; has been flight tested                                                                                                                                                                                 |

★ Indicates changes since September, 1961, Astrolog

| PROJECT                       | CONTRACTORS                                                                                                                                                                              | DESCRIPTION                                                                                                                                                         | STATUS                                                                                                                                                                                                                                                                                                 |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>*DAVY CROCKETT</b> (Army)  | In-house project directed by Rock Island, Ill., arsenal                                                                                                                                  | Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men | Some already deployed in Europe; official deployment date—December                                                                                                                                                                                                                                     |
| <b>ENTAC</b> (Army)           | Nord Aviation, prime                                                                                                                                                                     | Anti-tank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided.                                                                                                        | Operational; Army buying from French in quantity                                                                                                                                                                                                                                                       |
| <b>FABMIDS</b> (Army)         | GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies                                                                                                              | Mobile anti-missile defense system                                                                                                                                  | Each of six contractors have \$250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61                                                                                                                                                                                           |
| <b>FALCON</b> (Air Force)     | Hughes, prime; Hughes, guidance; Thiokol, propulsion                                                                                                                                     | Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 model has nuclear warhead                                                                             | Operational; buy-out of GAR 3A, 4A and 11 in FY '62                                                                                                                                                                                                                                                    |
| <b>GENIE</b> (Air Force)      | Douglas, prime; Aerojet-General, propulsion                                                                                                                                              | Air-to-air unguided; 1.5-mile range; nuclear                                                                                                                        | Operational                                                                                                                                                                                                                                                                                            |
| <b>GIMLET</b> (Navy)          | No contract announced                                                                                                                                                                    | Air-to-surface; unguided; considered highly accurate                                                                                                                | R&D                                                                                                                                                                                                                                                                                                    |
| <b>HAWK</b> (Army)            | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion                                                                                                                         | Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes                                                                               | Operational; deployed in Europe; Panama, Okinawa, U.S. (13 battalions); SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another                                                                                                     |
| <b>HONEST JOHN</b> (Army)     | Douglas/Emerson Electric, prime; Hercules, propulsion                                                                                                                                    | Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter                                            | Operational; deployed in Europe                                                                                                                                                                                                                                                                        |
| <b>HOUND DOG</b> (Air Force)  | North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion                                                                                                               | Air breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear                                                                                           | Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400                                                                                                                                                                                                      |
| <b>*JUPITER</b> (Army)        | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle                                                                                       | IRBM; liquid; nuclear; can be made mobile                                                                                                                           | Operational in Italy (30 launchers) with Italian AF; being deployed in Turkey; 30 R&D launchings: 23 successes, 5 partials, 2 failures. 26 Italian training launchings: 2 successes                                                                                                                    |
| <b>LACROSSE</b> (Army)        | Martin, prime; Martin, guidance; Thiokol, propulsion                                                                                                                                     | Surface-to-surface; highly mobile; 20-mile range; solid; nuclear                                                                                                    | Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped                                                                                                                                                                                                         |
| <b>LAW</b> (Army)             | Hesse-Eastern Div., Flightex Fabrics, prime                                                                                                                                              | Light anti-tank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter                                                                                 | R&D under AOMC                                                                                                                                                                                                                                                                                         |
| <b>LITTLE JOHN</b> (Army)     | Emerson Electric, prime; Hercules Powder, propulsion                                                                                                                                     | Surface-to-surface; unguided; 10-mile range; solid; nuclear                                                                                                         | First 4-launcher battalion operational this winter                                                                                                                                                                                                                                                     |
| <b>LOBBER</b> (Army)          | No contract announced                                                                                                                                                                    | Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BAL-LISTA                                                     | Studies                                                                                                                                                                                                                                                                                                |
| <b>LULU</b> (Navy)            | General Mills/Naval Ordnance Lab, prime                                                                                                                                                  | Small nuclear depth charge air-dropped or launched by ASROC                                                                                                         | Operational                                                                                                                                                                                                                                                                                            |
| <b>MACE</b> (Air Force)       | Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion                                                                                                             | Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid-nuclear; B model has more than 1200 mile range                                         | Being deployed with U.S. troops in West Germany; now all mobile but hard-base version development completed; to be in Okinawa, Korea                                                                                                                                                                   |
| <b>MATADOR</b> (Air Force)    | Martin, prime; Thiokol/Allison, propulsion                                                                                                                                               | Air-breathing surface-to-surface; 650 mile range                                                                                                                    | Being turned over to West Germans; also deployed in Far East                                                                                                                                                                                                                                           |
| <b>MAULER</b> (Army)          | GD/Astronautics, prime                                                                                                                                                                   | Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher                      | R&D; NATO may buy                                                                                                                                                                                                                                                                                      |
| <b>*MINUTEMAN</b> (Air Force) | Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF, rail launcher | 2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages                                                                               | R&D; scheduled to be operational mid-1962 at Malmstrom AFB; 4 Launchings: 2 successful, 1 partial; 1 failure tactical rail system tests completed; 3 squadrons at Malmstrom, Mont.; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D. 12 fixed squadrons now planned; mobile system indefinitely postponed |
| <b>M-55</b> (Army)            | Norris Thermador, prime                                                                                                                                                                  | Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers                                                                       | Operational                                                                                                                                                                                                                                                                                            |
| <b>MISSILE A</b> (Army)       | ARGMA, prime                                                                                                                                                                             | Surface-to-surface; 10-20 mile range; solid                                                                                                                         | Design studies                                                                                                                                                                                                                                                                                         |
| <b>MISSILE-B</b> (Army)       | No contractors announced                                                                                                                                                                 | A highly mobile general purpose missile; range 30-50 miles.                                                                                                         | Study                                                                                                                                                                                                                                                                                                  |



| PROJECT                            | CONTRACTORS                                                                                                 | DESCRIPTION                                                                                                                                                                                                                                       | STATUS                                                                                                                                                                                                                                                                                                                       |
|------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NIKE-AJAX</b> (Army)            | Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe                 | Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional                                                                                                                                                                             | Deployed in U.S., Europe & Far East; about 170 batteries in U.S., sixty-eight more to be phased out and replaced with NIKE-HERCULES                                                                                                                                                                                          |
| <b>NIKE-HERCULES</b> (Army)        | Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion; Douglas, airframe      | Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed                                                                                                                                                | Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa                                                                                                                                                                             |
| <b>NIKE-ZEUS</b> (Army)            | Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion; Douglas, airframe     | Anti-missile; 3-stage; 200-mile range; solid; nuclear                                                                                                                                                                                             | R&D test launchings at White Sands, 27 R&D launchings; 14 successful, 11 partial, 2 failures. Full missile tests to begin this month from Pt. Mugu, Calif.; complete system tests now scheduled for early '62                                                                                                                |
| <b>PERSHING</b> (Army)             | Martin, prime; Bendix, guidance, Thiokol, propulsion                                                        | Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range                                                                                   | R&D; to replace REDSTONE; 24 R&D launchings; 20 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 4 failures. Operational late 1961; R&D launching about 250 miles April 21                                                                                                            |
| <b>POLARIS</b> (Navy)              | Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle | Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D; possible A-4 4000-5000 mile range missile under study | 99 launchings of test vehicles; 69 successes; 24 partial; 6 failures; 31 also launched from submerged subs—all cleared surface; 21 successful flights, 10 failures. Five subs each with 16 missiles operational. Total authorized by White House: 29 Polaris II R&D missile successfully launched from submerged Ethan Allen |
| <b>QUAIL</b> (Air Force)           | McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment                    | ECM-carrying bomber decoy; about 200 m. range; jet powered                                                                                                                                                                                        | Deployed at SAC bases; carried by B-52                                                                                                                                                                                                                                                                                       |
| <b>RAVEN</b> (Navy)                | No contract announced                                                                                       | Air-to-surface; about 500-mile range                                                                                                                                                                                                              | Study                                                                                                                                                                                                                                                                                                                        |
| <b>REDEYE</b> (Army)               | GD/Astronautics, prime; Philco/Convair Atlantic Research, propulsion                                        | Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable                                                                                                                                      | Late R&D; deployment delayed until late 1962; Marines also will use; NATO may buy                                                                                                                                                                                                                                            |
| <b>REDSTONE</b> (Army)             | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion                                          | Surface-to-surface; liquid; 200-mile range; nuclear                                                                                                                                                                                               | Deployed with U.S. troops in Europe; to be replaced by PERSHING                                                                                                                                                                                                                                                              |
| <b>REGULUS I</b> (Navy)            | Chance Vought, prime and guidance; Aerojet-General, propulsion                                              | Surface-to-surface; turbojet & solid; 500-mile range; nuclear                                                                                                                                                                                     | Deployed aboard U.S. submarines; REGULUS II used as target drone                                                                                                                                                                                                                                                             |
| <b>SEMPER</b> (Marines)            | No contracts announced                                                                                      | Believed to be an air-launched missile                                                                                                                                                                                                            | R&D testing at Pt. Mugu                                                                                                                                                                                                                                                                                                      |
| <b>SERGEANT</b> (Army)             | Sperry, prime; Sperry, guidance; Thiokol, propulsion                                                        | Surface-to-surface; solid; more than 75-mile range; nuclear                                                                                                                                                                                       | In production; DOD reported to be considering cancellation; SERGEANTS scheduled to be deployed in Europe in 1962                                                                                                                                                                                                             |
| <b>SHILLELAGH</b> (Army)           | Aeronutronic, prime                                                                                         | Surface-to-surface; lightweight; can be vehicle-mounted                                                                                                                                                                                           | R&D                                                                                                                                                                                                                                                                                                                          |
| <b>SHRIKE</b> (Navy)               | NOTS-China Lake, prime; Texas Instruments, guidance                                                         | Air-to-surface; anti-radar; formerly called ARM                                                                                                                                                                                                   | R&D                                                                                                                                                                                                                                                                                                                          |
| <b>SIDEWINDER</b> (Navy-Air Force) | GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion                                        | Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads                                                                                                                       | Deployed with Navy and Air Force; all-weather type under development                                                                                                                                                                                                                                                         |
| <b>SKYBOLT</b> (Air Force)         | Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle                             | ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52 and Vulcan bombers                                                                                                                                                      | R&D; to be purchased by British; operational 1964; air drops of inert birds being conducted                                                                                                                                                                                                                                  |
| <b>SLAM</b> (Air Force)            | No contract announced                                                                                       | Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead                                                                                                                                                                          | Study-R&D                                                                                                                                                                                                                                                                                                                    |
| <b>SPARROW III</b> (Navy)          | Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion                                    | Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional                                                                                                                                                               | Operational with carrier aircraft earlier SPARROW I obsolete; new contract extending range, altitude                                                                                                                                                                                                                         |
| <b>THROBROCK</b> (Navy)            | Goodyear, prime; Kearfott, guidance; Thiokol, propulsion; Librascope, fire control                          | Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear                                                                                                                                                                             | Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine                                                                                                                                                                                                                         |
| <b>S-10</b> (Army)                 | Nord Aviation, prime; GE, U.S. licensee                                                                     | Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional                                                                                                                                                | Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. Army phasing it out                                                                                                                                                                                                      |
| <b>S-11</b> (Army)                 | Nord Aviation, prime; G.E., U.S. licensee                                                                   | Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional                                                                                                                                                | Operational, to be used with airborne units                                                                                                                                                                                                                                                                                  |

| PROJECT                        | CONTRACTORS                                                                                                                                                                | DESCRIPTION                                                                                                                                                                                                               | STATUS                                                                                                                                                                                                                                                                                   |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TALOS</b> (Navy)            | Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion                                                                                                 | Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear                                                                                                                                                      | Operational aboard cruiser Galveston                                                                                                                                                                                                                                                     |
| <b>TARTAR</b> (Navy)           | Convair, prime; Raytheon, guidance; Aerojet-General, propulsion                                                                                                            | Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional                                                                                                           | Operational on Missile Destroyer Adams in Oct.                                                                                                                                                                                                                                           |
| <b>TERNE</b> (Navy)            | Kongsberg Vapenfabrikk, prime; Arma, systems integration                                                                                                                   | Surface-to-underwater ASW missile; 264 lbs; HE warhead                                                                                                                                                                    | Navy buying from Norway to equip two destroyer escorts                                                                                                                                                                                                                                   |
| <b>TERRIER</b> (Navy)          | GD/Astronautics, prime; Reeves/FTL, Sperry guidance; ABL, propulsion                                                                                                       | Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional                                                                                                                                                 | Operational with fleet                                                                                                                                                                                                                                                                   |
| <b>TERRIER-ADVANCED</b> (Navy) | GD/Astronautics, prime; Reeves/FTL, Sperry guidance; ABL, propulsion                                                                                                       | About 100% performance improvement over TERRIER                                                                                                                                                                           | Operational with fleet; being deployed on destroyers and carriers                                                                                                                                                                                                                        |
| <b>★THOR</b> (Air Force)       | Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle                                                                                       | Surface-to-surface IRBM; 1500-mile range; liquid; nuclear                                                                                                                                                                 | Operational; 4 bases (60 launchers) set up in England. 68 military launchings: 47 successes; 11 partial; 10 failures. 61 scientific launchings: 52 successful; 2 partial; 7 failures                                                                                                     |
| <b>★TITAN</b> (Air Force)      | Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle | Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed | 44 launchings test vehicles: 32 successes; 8 partial; 4 failures. 8 bases for 12 squadrons planned; TITAN I scheduled to be operational mid-1961; TITAN II scheduled operational early 1963; TITAN I successfully launched from TITAN II silo; first TITAN II test scheduled in November |
| <b>★TOMAHAWK</b> (Army)        | Martin, prime                                                                                                                                                              | Anti tank                                                                                                                                                                                                                 | Study                                                                                                                                                                                                                                                                                    |
| <b>★TYPHON</b> (Navy)          | Bendix, missile; Westinghouse, ship-board control                                                                                                                          | Medium and long range sea-going anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic                                                         | R&D                                                                                                                                                                                                                                                                                      |
| <b>WAGTAIL</b> (Air Force)     | Minneapolis-Honeywell, prime                                                                                                                                               | Family of airborne RLM's (rear-launched missiles); air-to-air and air-to-surface                                                                                                                                          | Late R&D                                                                                                                                                                                                                                                                                 |
| <b>WILLOW</b> (Army)           | Chrysler, prime                                                                                                                                                            | Highly-classified missile                                                                                                                                                                                                 | R&D                                                                                                                                                                                                                                                                                      |
| <b>ZUNI</b> (Navy)             | Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion                                                                                                             | Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional                                                                                                                                                     | Operational                                                                                                                                                                                                                                                                              |



## Satellites and Spacecraft

| PROJECT                            | CONTRACTORS                                                                                      | DESCRIPTION                                                                                                                                                                                 | STATUS                                                                                                                                          |
|------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ADVENT</b> (Army)               | Army Signal Corps, prime; Bendix prime for 24-hour satellite communications package; GE, vehicle | Twenty-four hour instantaneous repeater communications satellite; more than 1250 lbs.; program incorporates Projects STEER, DECREE and COURIER; probably will use advanced TITAN II booster | R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first launchings late '62 |
| <b>ANNA</b> (Army, Navy, AF, NASA) | No contractors announced                                                                         | Geodetic satellite; 50-100 lbs.; probably spherical                                                                                                                                         | Study                                                                                                                                           |
| <b>AEROS</b> (NASA)                | No contract announced                                                                            | 24-hour weather satellite                                                                                                                                                                   | Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon                                           |
| <b>★APOLLO</b> (NASA)              | MIT, guidance                                                                                    | Three-man spacecraft capable of orbiting moon or becoming space station; boosted by SATURN and probably NOVA                                                                                | Five contractors—GE, Martin, GD/Astronautics, NAA, McDonnell—competing for prime; awards due by end of year; lunar landing now expected 1967-68 |
| <b>ARENTS</b> (ARPA)               | GD/Astronautics, prime                                                                           | Satellites to investigate deep space; 22,000 m. orbits; ATLAS-CENTAUR booster                                                                                                               | Contract let to build three payloads; launchings begin early '62                                                                                |
| <b>ASP</b> (Air Force)             | No contracts announced                                                                           | Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space                                                                                                       | Study                                                                                                                                           |
| <b>BAMBI</b> (ARPA)                | GD/Astronautics, STL                                                                             | Satellite system capable of intercepting enemy missiles in boost phase                                                                                                                      | Studies                                                                                                                                         |



| PROJECT                 | CONTRACTORS                                                                                                                   | DESCRIPTION                                                                                                                                                      | STATUS                                                                                                                                                                                               |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSAR (Air Force)        | No contracts announced                                                                                                        | Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors                                                           | Studies; possibly operational mid-60's                                                                                                                                                               |
| DISCOVERER (Air Force)  | Lockheed, prime; GE, re-entry vehicle                                                                                         | THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems                              | Launchings: 33; 9 capsules recovered from orbit (6 air-snatched) after orbiting earth one to three days; plans to put simians in capsules scrapped.                                                  |
| DYNA-SOAR I (Air Force) | Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link | Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN II booster; 3rd powered stage to be added                                               | R&D; first glider flights from Edwards AFB 1962; R&D suborbital flight about early 1965; program accelerated somewhat under FY '62 budget; considerable acceleration still under consideration       |
| ECHO (NASA)             | Langley Research Center, prime                                                                                                | ECHO I: 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; ECHO II: 135-ft., 700-mi. orbit                                           | In orbit since Aug. 12, 1960; ECHO II scheduled to be launched 1962; sub-orbital tests late '61 and early '62                                                                                        |
| MARINER (NASA)          | JPL, prime                                                                                                                    | 450 lbs unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B                                                                          | Seven shots planned. First scheduled Venus fly-by Aug. 1962                                                                                                                                          |
| MERCURY (NASA)          | McDonnell, capsule                                                                                                            | First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket)                                                                                       | First manned orbit shot expected late 1961 or early 1962. Sub-orbited launchings with REDSTONE ended after two successes; orbital shot with simian scheduled this month to precede manned shot       |
| MIDAS (Air Force)       | Lockheed, prime; Aerojet, IR detector system                                                                                  | Early-warning satellite; detect ICBM launchings by IR before birds leave pad; R&D models weigh 2.5 tons; operational system 12-15 satellites                     | R&D; second launching May 24, 1960 partial success; MIDAS III successfully launched July 12; MIDAS IV successfully launched Oct. 21, detected TITAN launching Oct. 24 within two minutes of ignition |
| IMBUS (NASA)            | GE, prime                                                                                                                     | 2nd generation weather satellite; 650 lbs.; 6 TV cameras in payload; THOR-AGENA B booster                                                                        | First launching scheduled for late 1962                                                                                                                                                              |
| AO (NASA)               | Grumman, prime; Westinghouse, electronic components; GE, stabilization and control                                            | 3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B                                                           | First flight scheduled in late 1963 or 1964                                                                                                                                                          |
| OGO (NASA)              | Space Technology Laboratories, prime                                                                                          | 1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B; THOR-AGENA B, CENTAUR boosters | First flight scheduled in 1963                                                                                                                                                                       |
| OSO (NASA)              | Ball Brothers, prime                                                                                                          | 440-lb. orbiting solar observatory; THOR-DELTA booster, S-16 early version; S-17 and S-57 advanced versions                                                      | First flight planned this fall for S-16; first flight for S-17 planned for 1962                                                                                                                      |
| PROSPECTOR (NASA)       | No contract announced                                                                                                         | Soft-landed, remote control, unmanned moon exploring or manned-lunar support spacecraft; SATURN booster                                                          | Schedule to be determined                                                                                                                                                                            |
| RANGER (NASA)           | JPL, prime; Aeronutronic, capsule; Hercules, retrorocket                                                                      | 300-lb. instrumented capsule rough landed on moon; ATLAS-AGENA B booster                                                                                         | R&D; first flight Aug. 23, RANGER failed to launch from orbit; next shot slipped to November; first lunar landing planned for 1962; nine RANGERS planned                                             |
| EBOUND (NASA)           | No contract announced                                                                                                         | System of 3 to 6 multi-launched ECHO II communications satellites                                                                                                | First orbital flight scheduled for 1963 or 1964                                                                                                                                                      |
| ELAY (NASA)             | RCA, prime                                                                                                                    | 100-lb active repeater experimental communications satellites. Commercial system planned; DELTA booster                                                          | Britain, France and Germany building ground stations; Latin American interest sought; first launching next year                                                                                      |
| AINT (Air Force)        | RCA, prime                                                                                                                    | Anti-satellite satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS launched                                              | R&D to be launched against reflectors or balloons in 400-mi. orbits late '61                                                                                                                         |
| SAMOS (Air Force)       | Lockheed, prime                                                                                                               | Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.                                                                                            | R&D; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; SAMOS III launching failed Sept. 9                             |
| OMAR (Air Force)        | Lockheed and Martin, prime                                                                                                    | Logistics, maintenance, supply spacecraft for space systems                                                                                                      | Study contracts awarded in December                                                                                                                                                                  |
| IRVEYOR (NASA)          | Hughes, prime                                                                                                                 | 750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster                                                                          | First moon flights 1963; seven or more to be launched by 1965                                                                                                                                        |
| INCOM (NASA)            | Hughes, prime                                                                                                                 | 24-hr. instantaneous repeater communications satellite. DELTA booster                                                                                            | R&D; first launching scheduled late 1962                                                                                                                                                             |

| PROJECT                | CONTRACTORS                                | DESCRIPTION                                                                                                                                                               | STATUS                                                                                                                                                                                                                                                                  |
|------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ★TELESTAR (AT&T-NASA)  | BTL, management for AT&T                   | 125 lb., active repeater, experimental industry communication satellite; DELTA booster                                                                                    | R&D; four satellites planned; first launching scheduled April 1962 by NASA on cost-reimbursed basis                                                                                                                                                                     |
| ★TIROS (NASA-Wea. Bu.) | RCA, prime                                 | Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner                                                                                         | R&D; first launching April, 1960; second last Nov. 23; third July 12, all successful; four more planned. Total planned: 7                                                                                                                                               |
| TRANSIT (Navy)         | Applied Physics Laboratory, prime          | Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.                                                                          | TRANSIT IB R&D satellite in orbit April 13, 1960; IIA plus piggyback satellite in orbit June 22; TRANSIT IIB launched into poor orbit Feb. 21; IVA orbited June 29 with 2 piggy-back payloads that failed to separate; 4-satellite system scheduled to be in orbit 1962 |
| VOYAGER (NASA)         | No contract announced                      | Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster                                                                                    | Study; first flight planned by 1965                                                                                                                                                                                                                                     |
| YO YO (Navy)           | No contract announced                      | Tactical sea-launched one-pass reconnaissance satellite                                                                                                                   | R&D                                                                                                                                                                                                                                                                     |
| ★X-15 (NASA-AF-Navy)   | North American, prime; Thiokol, propulsion | Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-II rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered. | Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-II engine; plane #2 with XLR-99 engine turned over to NASA has hit 3920 mph speed record; altitude record of 217,000 ft. (unofficial for manned, powered flight)                |



## Space Vehicles

|                                |                                                                                                                                                      |                                                                                                                                                                           |                                                                                                                                                                                                                                                    |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AGENA (Air Force)              | Lockheed, prime; Bell, propulsion                                                                                                                    | 1700-pound satellite after burnout; AGENA B stop-start 2450-lb. engine; about fuel capacity AGENA A                                                                       | Used in DISCOVERER program; large AGENA B also to be used with ATLAS and THOR                                                                                                                                                                      |
| BLUE SCOUT (Air Force)         | Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion                                                          | Solid multi-stage booster based on SCOUT components                                                                                                                       | Operational                                                                                                                                                                                                                                        |
| ★CENTAUR (NASA)                | GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance                                                                 | Pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.                             | First flight test slipped to early 1962; first engine delivered                                                                                                                                                                                    |
| ★DELTA (NASA)                  | Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion                                                                                 | Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity                                                                                                    | Interim launch vehicle for TIROS-ECHO; being used for other satellites and on deep space probe; 26 on order                                                                                                                                        |
| ★NOVA-L (NASA)                 | No prime announced; Rocketdyne, propulsion                                                                                                           | Clustered 6-12 million lb. liquid propellant booster plus upper stages                                                                                                    | R&D on 1.5 million lb. F-1 engine; vehicle contract expected to be awarded this fall; F-1 test-fired 19 times a more than 1 million lbs. thrust; program may be integrated with SATURN                                                             |
| NOVA-S (Air Force)             | No contractor announced; expected to be based on Aerojet/Grand Central feasibility studies                                                           | Clustered 12-million—20-million-lb. booster; possible alternative to NOVA-L                                                                                               | R&D; contracts expected to be let this year                                                                                                                                                                                                        |
| ORION (Air Force)              | General Atomic                                                                                                                                       | Space booster launched by series of atomic explosions                                                                                                                     | Advanced engineering studies under way; tests may be attempted with resumption of nuclear testing                                                                                                                                                  |
| PHOENIX (Air Force)            | No contracts announced                                                                                                                               | Recoverable booster—possibly a modified F-1                                                                                                                               | Studies                                                                                                                                                                                                                                            |
| ★ROVER (NASA, AEC)             | Aerojet, NERVA prime, Westinghouse, propulsion                                                                                                       | First nuclear rocket: KIWI non-flying test engines and NERVA flight engines                                                                                               | First NERVA test flight expected 1961                                                                                                                                                                                                              |
| ★SATURN (NASA)                 | Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines | Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload | First C-1 launching Oct. 27 from Cape successful; booster with inert upper stages flew 214.7 miles, (84.8 m. apogee); flight with live upper stages scheduled 1963. C-2 killed, C-3 to have two F-1's in 1st stage; C-4, four F-1's C-5 five F-1's |
| SCOUT (NASA)                   | Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion                                              | Solid four-stage satellite launcher; 200 lb. payload in orbit                                                                                                             | SCOUT flights in '61 completes R&D; Navy proposing SEASCOU for submarine surface launch, would be based on POLARIS and SCOUT                                                                                                                       |
| THOR-ABLESTAR (Air Force-NASA) | STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion                                                                                               | Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine                                                                                           | THOR-ABLE phased out. Used in TRANSIT and COURIER                                                                                                                                                                                                  |





# Satellites in Orbit

**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 217 m., apogee 1092 m., period 106.1 min. (Discovered Van Allen Belt); not transmitting.

**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 404, apogee 2448, period 133.8; transmitting.

**NIK I "MECHTA"** (3245 lbs.) Russia. Launched 1/2/59. Believed to be in orbit around sun on 15-mo. cycle; not transmitting.

**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 354, apogee 2037, period 5.3; inclination to equator 32.88°; not transmitting.

**ONEER IV** (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun, and achieved primary mission—earth-moon trajectory; not transmitting.

**EXPLORER VI "PADDLEWHEEL"** (142 lbs.) U.S. Launched 8/7/59. Orbits earth; initial perigee 156, initial apogee 26,357, initial period 1 1/2 hrs., present orbit uncertain.

**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 150 years. Orbits earth; perigee 317, apogee 2320, period 129.8; not transmitting.

**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 669, period 101.1; transmitting.

**ONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits earth, interplanetary environment probe; completed one full orbit 1/16/61; perihelion .9951 au, perihelion .8061 au, not transmitting.

**ROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 467, period 101.1; transmitting.

**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 407, period 94.8. First R&D navigation satellite. Not transmitting.

**PUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 1/429 on 5/19/60; last reported—perigee 175, apogee 286, period 100.0. Test of support systems, cabin, for manned space flight; attempt return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 294, apogee 317, period 94.3 Telemetry for IR scanning failed two days after launch. Not transmitting.

**ANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth; perigee 389, apogee 649, period 101.6. Transmitting.

**SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Not transmitting.

**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 673, apogee 1224, period 116.5. First successful orbiting passive communications satellite.

**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 599, apogee 755, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

**EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 262, apogee 1409, period 112.5. Provides ionospheric measurements for communications. Not transmitting.

**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 461, period 98.2. Transmitting.

**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apogee 340, period 94.9. First R&D reconnaissance satellite.

**VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61, aphelion 1.0190 au, perihelion 0.7183 au.

**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 466, apogee 1524, period 118.1. A 12-ft. "polka dot" balloon.

**DISCOVERER VV** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 176, apogee 382, period 93.6. No attempt to recover 300-lb. capsule because of malfunction.

**DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 154, apogee 462, period 94.6. Carried IR equipment for MIDAS program to measure background radiation from earth.

**EXPLORER X** (78 lbs.) U.S. Launched 3/25/61. Last known position; perigee 110, apogee 112,500, period 50.12. Optical pumping magnetometer. Position uncertain.

**DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 183, apogee 313, period 92.6. Capsule ejected in wrong direction, sending it further into space. Not transmitting.

**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth; perigee 302, apogee 1108, period 107.8. Measures gamma rays from the stars absorbed in earth's atmosphere.

**TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs.; INJUN, 40 lbs.) U.S. Launched 6/29/61. Orbits earth; TRANSIT—perigee 547, apogee 620, period 103.8. GREB-INJUN—perigee 548, apogee 619, period 103.8. Transmitting. GREB III and INJUN failed to separate after three-in-one launch.

**DISCOVERER XXVI** (2100 lbs.) U.S. Launched 7/7/61. Orbits earth; perigee 142, apogee 315, period 92.0. Systems evaluation of AGENA B. Capsule recovered.

**TIROS III** (285 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 457, apogee 511, period 100.3. Transmitting cloud cover weather pictures.

**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits earth, perigee 2084, apogee 2197, period 161.5. IR early warning satellite.

**EXPLORER XII** (83 lbs.) U.S. Launched 8/15/61. Orbits earth; perigee 284, apogee 47,952, period 1593. Study Van Allen belts and energetic particles in space.

**DISCOVERER XXX** (2100 lbs.) U.S. Launched 9/12/61. Orbits earth; perigee 144, apogee 281, period 91.4. Capsule recovered in the air. Space radiation experiments.

**DISCOVERER XXXII** (2100 lbs.) U.S. Launched 10/13/61. Orbits earth; perigee 145, apogee 223, period 90.5. Capsule recovered in the air. Contained space radiation experiments.

**MIDAS IV** (3500 lbs.) U.S. Launched 10/21/61. Orbits earth; approximately 2100 circular; period 172. IR scanning early-warning satellite. Transmitting.

**WESTFORD BELT** (75 lbs.) U.S. Launched 10/21/61. Orbits earth; approximately 2100 circular.

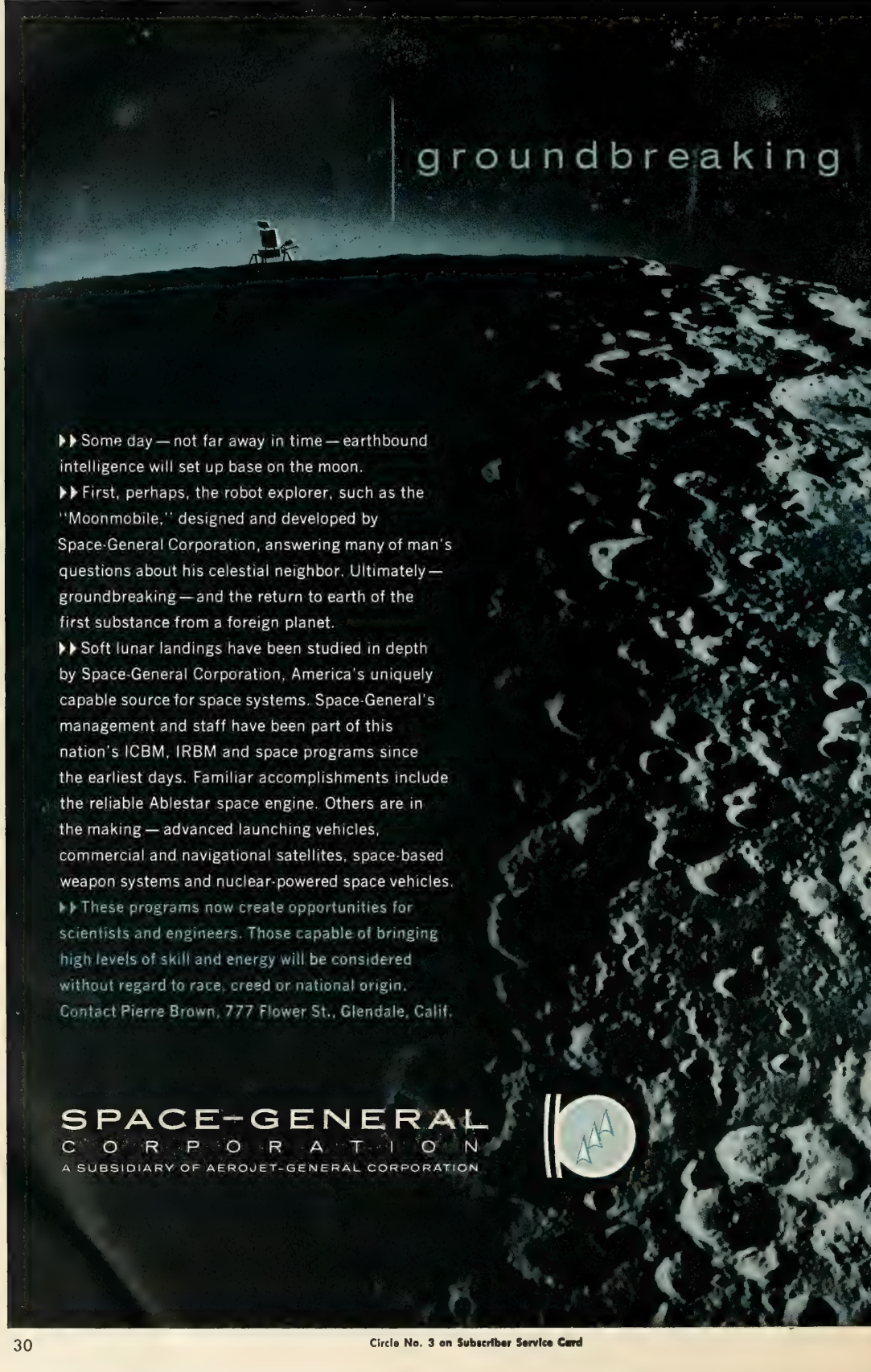
*(Orbital data is latest official information as of 1200 Z, October 24, 1961)*

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# Technical Countdown

## ELECTRONICS

### Microwave Tube Capabilities Extended

A high perveance gun—developed by Raytheon's Spenser Laboratory, is increasing the capabilities of hollow beam microwave tubes. Company officials say the chief advantages of the magnetron injection gun are low voltage operation, lower x-ray level, enhanced bandwidth and longer life. The tubes are to be available by the end of this year.

### VSMR Gets Parametric Amplifier

A powerful parametric amplifier has been installed and is operating in a FPS-16 radar unit at White Sands Missile Range. Varian Associates, builders and installers of the unit, says the amplifier increased the radar range by approximately 100% and decreased the radar noise from 11 db to 4 db with consequent boosting of the output power from 1 megawatt to 10 megawatts.

### Antenna Built for World-Wide TV

A tropospheric scatter antenna—available with reflectors 0, 60, and 120 feet across—has been built by the Boeing Co.'s Antenna Dept. for long range communications—including world-wide television. Capable of transmitting voice, television and computer data distances of 500 miles without signal boosters, the antenna's principal advantages, Boeing officials said, are the 5 to 10% lower initial cost and ease of assembly.

### Reactor Electricity by 1966

An atomic reactor using thermionic units in its fuel elements to convert heat directly into electricity could be operating as early as 1966, say Martin Co. scientists. Advance design work has been completed on direct conversion systems in the 60 and 300 kw power ranges. Lack of mechanical motion should lead to higher reliability and vibration prevention in place.

### Glass for Gas in Lasers

Larger lasers with more readily controlled output at less cost are possible by using glass instead of crystal or gas. American Optical Co. scientists say the use of glass permits the construction of specially-shaped lasers—including lasers in the form of glass fibers. The fiber's large surface area means easy removal of the tremendous heat generated during laser activity. This should, in turn, make it easier to obtain a solid continuous wave laser.

### West Ford Aside

A maneuverable microwave antenna system designed by the Boeing Co. installed in a KC-135 jet tanker was to be checked out in the ill-fated *West Ford* experiment. One missile and rockets, November 6, 1961

aspect was to determine the feasibility of bouncing communication signals off the band of filaments to distant points on earth. The second was to investigate the band for high flying aircraft and the extent to which planes could be used as relay points for communication with satellites, space vehicles and other aircraft.

## ADVANCED MATERIALS

### Super Cryogenic Insulation

A new insulation system is solving cryogenic and thermal control problems in *OGO*, *Ranger* and *Mariner*. Developed by National Research Corp. and dubbed NRC-2, the insulation was also used in two 7800-gal. semi-trailers built by Standard Steel and sold to NASA. The units carried liquid hydrogen across the U.S. without any "significant boil-off."

### Huge Forging Presses in U.S.S.R.?

The Soviet Central Scientific Research Institute of Technology and Machine Building says it has designed 50,000- and 200,000-ton capacity hydraulic presses with the body and other parts made from pre-stressed reinforced concrete. The concrete reduces metal consumption in building a 50,000-ton press by a factor of 5. The Russians phrased it this way. "The possibility of using this highly economic material is extremely important in connection with the necessity for building several 200,000-ton capacity presses."

### Tungsten Nozzles for AEC

High purity tungsten nozzle inserts with small grain size, reasonable machineability and good dimensional stability have been produced for the AEC by Union Carbide Nuclear Co. Inserts having densities ranging from 75-85% were sintered at a maximum of 4670° F in induction furnaces using a graphite susceptor and a flowing helium atmosphere.

## ASW ENGINEERING

### More Tests at AUTC

The deep waters of the Tongue of the Ocean in the British West Indies south of Nassau will shortly be used for acoustic instrumentation experiments by the Defense Systems Div. of General Motors. This geographic area is also part of the Navy's projected ASW missile range AUTC, which may soon be reverberating with underwater tests (M/R, Oct. 23, p. 40).

### Signatures Needed

Sonar signatures of hydrofoil craft skimming across the ocean are needed by the Navy's Bureau of Ships. Contract to gather them was recently awarded to Lockheed-California Co. (Div. of Lockheed Aircraft), which has been obtaining this type of data with a 17-foot catamaran using various foils.

# 'Bumper' May Cure Meteoroid Hazard

*Multiple-sheet hulls recommended for manned spacecraft; may affect Apollo design*

by William Beller

TWO NASA scientists are recommending using multiple-sheet hulls to protect manned spacecraft from the hazards of meteoroid impacts.

They say that "any other recourse could be disastrous to the occupants and mission of the space vehicle"—particularly for a manned 14-day lunar mission.

The recommendation in a report by C. Robert Nysmith and James L. Summers of NASA's Ames Research Center, Moffett Field, Calif., could have an important bearing on the design of *Apollo* and other manned spacecraft. Their calculations also show:

Even with such structural precautions taken, the danger of critical damage stemming from meteoroid impact is still present. The number of penetrations can be as high as three a day—on the average—for spacecraft hulls made of an otherwise structurally-adequate single sheet of aluminum; and although reduced for multiple-sheet structures, the number can still go up to one

penetration every 11 days.

• **Weight makes waste**—Clearly, the chance of a space vehicle being struck by a meteoroid varies with the trip length and exposed area of the craft. The most fearsome damage would come from a meteoroid having enough energy either to penetrate the spacecraft and cause explosive decompression, or to seriously damage critical equipment on board.

The problem can be simplified by assuming that "significant damage" is done whenever the hull is completely punctured.

One way to insure against hull penetration is to make the structure so impervious that the largest anticipated meteoroid would never pierce it—which would also lead to a vehicle so heavy it could not efficiently serve its mission.

• **Energy absorber**—A better approach is the multiple-sheet hull design suggested in 1947 by Dr. Fred L. Whipple of the Harvard College Observatory. The spacecraft would be surrounded by

the now familiar "meteor bumper," a thin outer shell spaced a distance out from the main hull.

Upon hitting the bumper, the less energetic meteoroids would vaporize, at the same time vaporizing a bit of the bumper material. On the other hand, the more energetic meteoroids might only be fragmented by the bumper. These pieces, plus those loosened from the bumper, would then impinge on the inner shell. But the total kinetic energy would be divided among many particles, thereby lowering the probability

of any one of them puncturing the material. This is the insurance provided by the multiple-sheet hull.

In the Ames' tests, projectiles simulating typical meteoroids were fired at high speed at structures made up of thin 2024-T3 aluminum alclad sheet placed one behind the other. During the tests, the thickness and number of sheets were varied, but the total thickness was held constant at 0.062 inches. In this way, the weight per unit area was held constant.

However, in one test the effect of placing a fluffy, glass-wool batting between the sheets was investigated. Here the added material increased by 30% the target's weight per unit area.

In all these tests, the penetration resistance of a multiple-sheet structure was measured by its "ballistic limit." This is an ordnance term defined as "The particular velocity . . . determined by test, at which the (multiple-sheet) plate will just resist complete penetration by the projectile in question."

The term is believed apt for spacecraft usage because any meteoroid penetration of a spacecraft hull would surely imperil the vehicle's mission.

Here are some of the results of the tests:

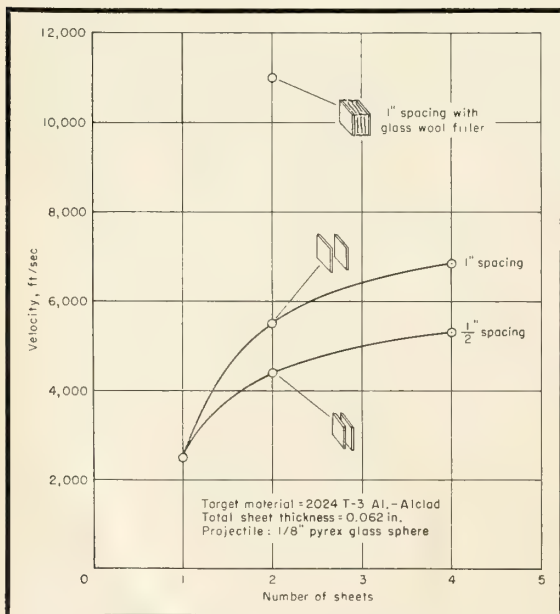
—Penetration resistance is increased by a factor of 1.75 when a single sheet of material is divided into two sheets (each half as thick as the original) spaced 1/2-in. apart.

—When the spacing between two sheets is increased to 1-in., the penetration resistance is increased by a factor of 2.2 over the single-sheet structure.

—Increasing the number of sheets from one to two is considerably more effective than increasing the number from two to four.

—The most substantial gain in penetration resistance is achieved by closing the void between the sheets with glass-wool filler. (Note that the unit weight with filler is 30% greater than without it.)

• **Two lunarcraft designs**—The data from these tests were used to calculate the probable survivability of two de-



HOW SHEET number varies ballistic limit



signs of manned spacecraft sent on 14-day lunar missions. The first design called for a hull made up of a single-sheet of constant thickness aluminum; and the second, for a double hull consisting of two equal-thickness aluminum skins separated by a space loosely filled with glass-wool insulation.

Specifically, the vehicle design was arbitrarily chosen to be a right circular cylinder able to contain a two-man space crew. The material selected was 2024-T3 aluminum alclad, which has a working strength of 20,000 psi. A single sheet 0.033 inches thick would be needed to hold a vehicle internal pressure of one atmosphere.

Thus, the multiple-sheet-hull design evaluated consisted of two 0.33-in. sheets of aluminum material spaced one inch apart, with the space between the sheets filled with glass wool.

Since this multiple-sheet design was to be compared on the basis of identical unit weights, the single-sheet hull was made 0.090 inches thick.

The probable masses of meteoroids encountered and their structures and compositions were judged on the basis of previous space research and theoretical considerations.

The masses and compositions of meteoroids were then combined to give in "optimistic" and a "pessimistic" outlook. The optimistic view came from an analysis assuming "dustball" meteoroids having a relatively small number of impacts per square foot per day. In the pessimistic view, the analysis assumed solid stoney meteoroids having a larger number of unit impacts.

The conclusions are:

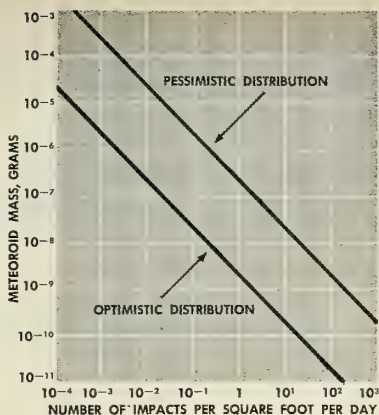
—If the optimistic outlook holds, then the number of penetrations is decreased from one every five years for the single-sheet design to one every 156 years for the multiple-sheet design.

—If the pessimistic outlook holds, the number of penetrations is reduced from 3 per day for the single-sheet design to one every 11 days for the multiple-sheet design.

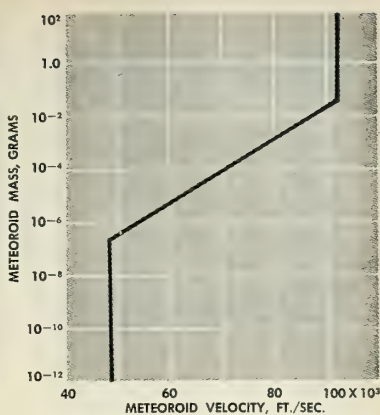
This means that the multiple-sheet design increases the relative effective flight time by a factor of 35.

"Even so, . . . a meteoroid hazard still exists even for a vehicle with multiple-sheet hull construction, particularly the pessimistic meteoroid hazard outlook represents the actual conditions in space," Nysmith and Summers point out in their report (NASA Technical Note D-1039, "Preliminary Investigation of Impact on Multiple-Sheet Structures and an Evaluation of the Meteoroid Hazard to Space Vehicles.")

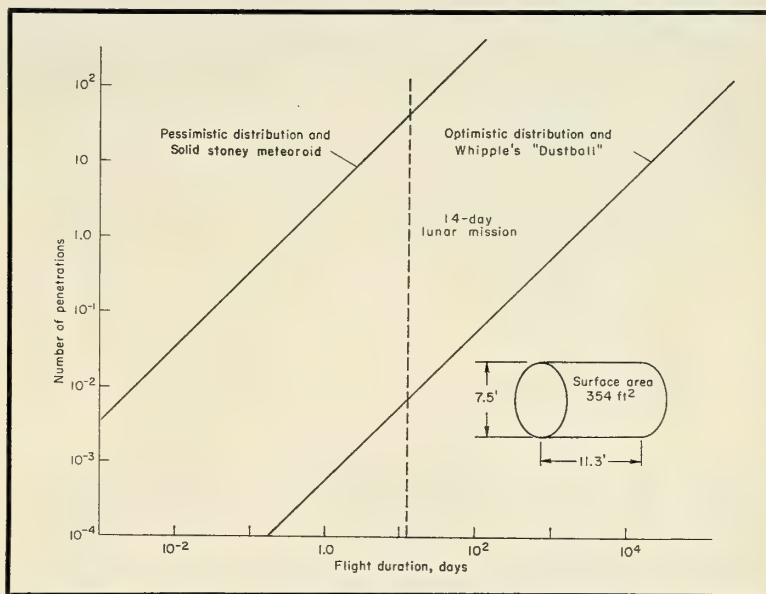
"Although it may seem unnecessary conservative to assume that this condition does exist in space," they add, "our knowledge . . . at the present time prohibits us from doing otherwise." ❖



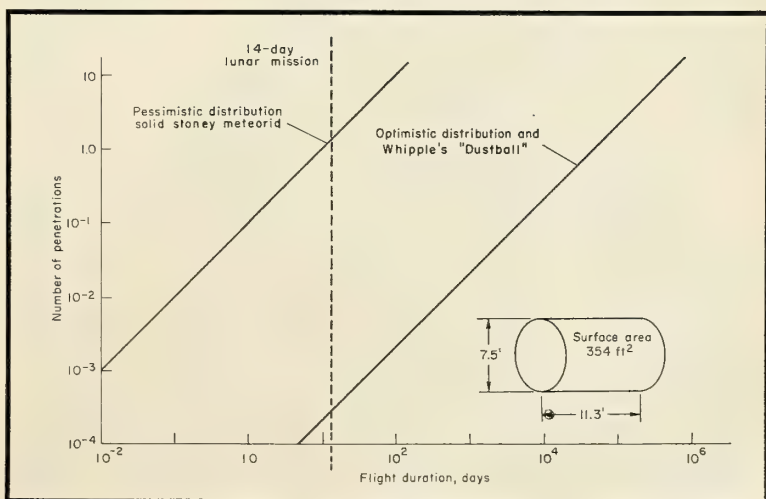
METEOROID Mass distribution



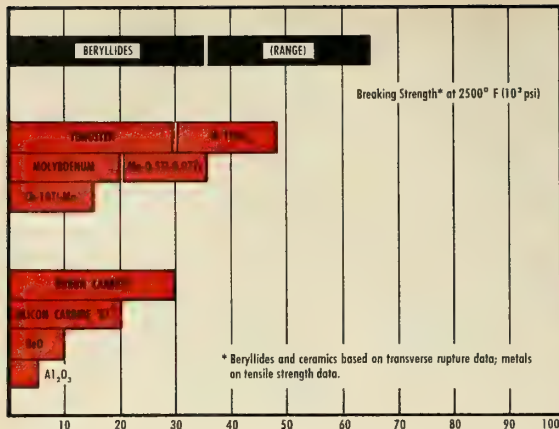
METEOROID velocity distribution



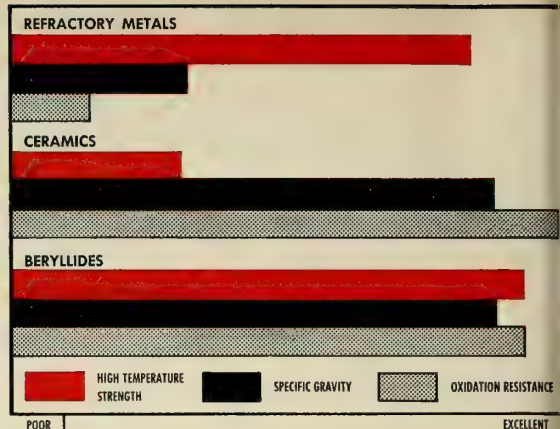
SINGLE sheet lunar vehicle hull



DOUBLE sheet, glass wool-filled lunar vehicle hull



**TENSILE STRENGTH DATA** for beryllides, carbides and oxides show how the three groups compare generally in their ability to resist breaking. Typical beryllide values range from 37,000 to 65,000 psi.



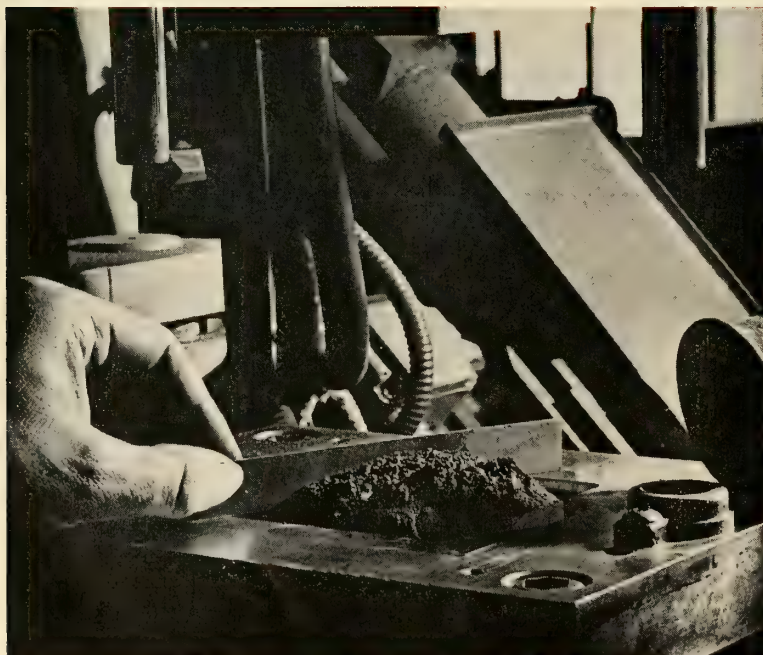
**GENERAL COMPARISON** in terms of the three key properties involved in materials evaluations for leading edges, wing and body panels, supporting structural members and others. The beryllides possess a unique combination of these.

## advanced materials

by John Judge

# Beryllides Boost Temperature Level

**Intermetallic compounds combine oxidation resistance, low weight, high heat strengths for hot structural applications**



**POWDERED** Beryllide is placed in a steel die for cold pressing. Standard powder metallurgy methods are followed in the part fabrication.

A FAMILY of compounds—beryllide intermetallics—capable of increasing the useful temperature of structural materials in missile/space applications by 50% are in commercial production by the Brush Beryllium Co.

Extremely strong and resistant to oxidation at 3000°F, the new materials weigh about the same as aluminum. While the beryllides fall short of the high use-temperatures of ceramics, they are more than ten times as strong at elevated temperatures.

The beryllides are made from beryllium chemically combined with refractory metals such as tantalum, columbium and zirconium. The materials contain no free amounts of either constituent metal. X-ray diffraction studies reveal completely different crystal structures and properties separate and distinct from those of the parent metals.

The first two available members of that family are beryllium-tantalum compounds— $TaBe_{12}$  and  $Ta_2Be_{17}$ . These are two of the seven compounds Brush scientists found most promising during a 5-year research and development effort.

Two zirconium and three columbium compounds are expected to be commercially available shortly.

• **High Heat Strength**—Peak values of modulus of rupture of the beryllides occur in the 2300°F range at values of 40,000 to 100,000 psi. At 2500°F, the

missiles and rockets, November 6, 1961



modulus decreases and there is a drop-off from one-half to two-thirds peak values when the temperature reaches 2750°F. But even at this last temperature, it takes 35,000 psi to rupture a bar of  $Ta_2Be_{17}$ , says Brush.

Determinations of oxidation resistance were made by subjecting the beryllides to streams of air at high temperatures for 100 hours. Penetration was then measured in mils. At 2500°F, penetration ranged from 0.3 mils in the case of  $Ta_2Be_{17}$  to 0.9 mils for  $NbBe_{12}$ . At 2700°F, the tantalum compound showed only 0.9 mils penetration.

**Typical Oxidation Resistance Properties**  
(Mils penetration in 100 hours)

|               | 2500 F | 2700 F |
|---------------|--------|--------|
| $TaBe_{12}$   | 0.5    | 0.9    |
| $Ta_2Be_{17}$ | 0.3    | 0.9    |
| $NbBe_{12}$   | 0.9    | 2.0    |
| $Nb_2Be_{17}$ | 0.6    | 1.9    |
| $ZrBe_{12}$   | 0.5    | 1.3    |
| $Zr_2Be_{17}$ | 0.5    | 1.2    |

The third key property as far as airborne and space applications are concerned is specific gravity. Like beryllium, the beryllides have low values—ranging from 2.72 to 5.05. This is an advantage over refractory metals such as tungsten and molybdenum which have specific gravities of 10.2 and 19.3 respectively. As a group, the beryllides are roughly equivalent in weight to ceramics, aluminum and titanium.

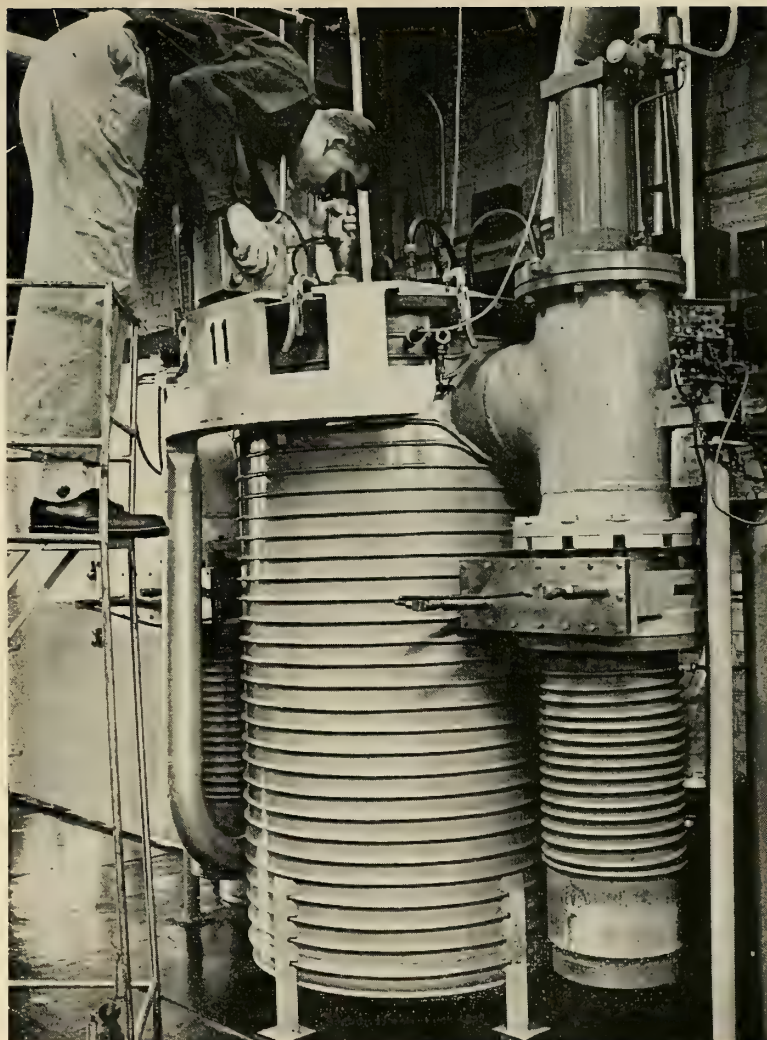
In the production of beryllides, the constituent metals are intimately blended in powder form and reacted at elevated temperatures. The resultant intermetallics are ground to powders for fabrication.

• **Theory to Practice**—Brush is actively investigating fabrication techniques under an Air Force contract. Progress has been made. One basic method is cold pressing and sintering. Similar to conventional ceramic processes, the beryllides are mixed with suitable binders, pressed in steel dies and fired.

The resultant shapes have densities 98 to 100% theoretical. Finishing methods depend on required tolerances; diamond grinding is used generally.

Isostatic pressing is another satisfactory process and cones and cylinders with high uniform density have been fabricated. Discs running 12 in. across and 1.5 in. thick have been made by hot pressing with larger parts feasible. Flame spraying has also been successful; so has extrusion and slip casting.

Three main categories of materials are under intensive development for high temperature applications across the U.S.—super alloys, refractory metals



*INTERMETALLICS are produced by reacting constituent metal powders in these furnaces. Optical pyrometer readings check the reaction's progress.*

and ceramics.

Brush compares the beryllides favorably with the super alloys. These alloys are temperature-limited to about 2200°F while the intermetallics have a top use-temperature approaching 3000°F. Their lightness is a factor.

Refractory metals must be coated to prevent or reduce oxidation. Beryllides are an even match in strength at temperatures over 2500°F and last longer.

Ceramics have it all over the beryllides in maximum use temperatures but the latter are much stronger. In addition, the thermal conductivity of the intermetallics is roughly twice that of the best ceramic at these working temperatures—an important consideration in heat sink applications. The thermal expansion properties of the beryllides are roughly the same as nickel, making them compatible for structural use with

other metals.

Brush's work in the intermetallics was supported in large part by both the Air Force, which initiated the operation, and the AEC. Contracts have totalled over \$1 million to date.

Sample quantities of the beryllides have been supplied to a number of prime contractors during the experimental phase of the development work. The powder form sold for \$300 per lb. Recent advances and production techniques have cut this by more than 50% and further reduction will be made as volume use develops.

The development of fabricating processes is underway. The seven members of the family will all be available shortly. Additional beryllides are being investigated together with some ternary systems—intermetallic systems made by reacting a third metal with a binary intermetallic compound. ❧



# Questions and Answers about the

## GLOBAL COMMUNICATIONS CAPABILITIES of RCA

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**In what ways does RCA make its capabilities available?**

As contractor or consultant. For more information, write RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4. Tel. Hanover 2-1811, Area Code 212.



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## NATO Missiles . . . . .

(Continued from page 13)

weapon with a long lifetime.

The organization chart (see p. 13) illustrates the complexities in setting up *Hawk* as NATO's first "Coordinated Production Project." The number of participating agencies stems unquestionably from the fact that it was started from scratch and everyone concerned was interested in putting in as many checks and balances as possible.

• **Company lineup**—Although it looks almost unworkable, both U.S. and European officials claim that with their initial problems out of the way the organization is functioning as smoothly as can be expected, and that work on the missile is going along quite well.

The main working bodies of the organization chart are Raytheon in the U.S. and SETEL. It is through Raytheon that technical work on the project is funnelled to SETEL, which in turn distributes the information to its National Prime Contractors. SETEL's technical group is called the Mandate. NPCs include C. F. Thomson Houston of France, Philips of the Netherlands, Ateliers de Construction Electrique de Charleroi of Belgium, Germany's Telefunken and Finmeccanica of Italy.

Underneath these companies are about 40 European subcontractors. Raytheon holds a 40% interest in one of them, Selenia of Italy.

Overall management of the project is under the direction of a retired Dutch lieutenant general, William J. Reynierse, who holds the title of Project Manager. He reports to the inter-governmental *Hawk* Production Organization.

On the U.S. side, the Army is the project's executive agency, with Redstone Arsenal's AOMC and ARGMA responsible for the operational end.

The key agency in Raytheon is the NATO Support Department headed by S. I. Gilman at Lawrence, Mass. Gilman has a 150-man group which handles the documentation and bird dogs all aspects of the program—including sending missions to plants to help set up special manufacturing facilities and other trouble shooting tasks.

Gilman's unit comes under Raytheon's Aero-Weapons Division and is supported by the Missile and Space Division as well as other components of the company. Raytheon also handles the flow of components from about 12 U.S. subcontractors.

• **Production phases**—The program for initiating European production is broken down into three main phases:

—Preliminary production for which the U.S. supplies complete "do-it-yourself" kits.

—Pre-production, involving the supply of components and parts.

—Production, involving the supply only of items the European makers are not able to produce.

In practice, the phasing-in of production is much like that of a manufacturer setting up a subsidiary production unit in another part of his country. Only in this case, the phasing-in is complicated by the language barrier, differences in word meaning when translated from English to French, German or Italian, and by the 3000-mi. distance between Raytheon and SETEL.

Translation of measurements from statute to metric has caused some problems, but these are being overcome by the employment of master gages and gears.

Some 5 million drawings, specs and technical instructions needed to produce the highly complex *Hawk* are handled through centers at Andover, Mass., and Paris. Much of this documentation has been reduced to microfilm and mounted on IBM cards, saving both time and storage space.

While problems remain on the working end, they are comparatively simple to those encountered in setting up *Hawk's* NATO organization.

Before the U.S. would agree to providing the weapon, it made the NATO countries commit themselves to building enough missiles to make the establishment of an industrial consortium economically feasible. It also laid down specific requirements on facilities and tooling, security regulations and the payment for know-how as well as hardware. It also made provision for feeding back to the U.S. any European-born improvements in *Hawk*.

These requirements then had to be met in individual contracts signed with the five participating countries, which in turn, had to comply within the framework of their own internal political, tax, budgetary and commercial interests.

As one lawyer put it: "It all came down to a lot of legal nitpicking."

Actual dollar figures are not available for the contribution to the program by each country. But each nation is to get only its pro-rata share of the work based on its contribution.

On this basis, West Germany is the largest contributor, paying for nine battalions of NATO *Hawks*. Italy and the U.S. are each taking four battalions (the U.S. already has several U.S. produced battalions deployed in Europe) and France, Belgium and the Netherlands are committed to three apiece.



**UNIVIS, INC.** formed a subsidiary, American Aerospace Controls, Farmingdale, N.Y. to produce and develop advanced space technological instruments and components.

Included will be the design and manufacture of proprietary precision electromechanical devices, reflective optical components and thin film transducers. Specialized R&D facilities are planned.

**SPACE TECHNOLOGY LABORATORIES, INC.** dedicated the first building of the new \$30 million Space Technology Center, Redondo Beach, Calif. will house research laboratories for space development programs. Among other buildings in the 110-acre-complex will be a high-bay manufacturing structure designed for fabrication and space environment testing of spacecraft and their sub-assemblies.

**IPSEN INDUSTRIES, INC.** formed the Refractory Metals Div. subsidiary in Rockford, Ill. to do research and development of ultra-high-temperature materials. Special emphasis will be placed on R&D of materials whose working temperatures exceed 3000°F.

**APPLIED MICROWAVE ELECTRONICS** began construction of an addition to its Baltimore, Md. plant. The addition will expand AME's machine tool facility and engineering test

laboratory and will add an automatic and integrated plating department and a brazing department.

**KOLLSMAN INDUSTRIES INC.** established Kollsman Instrument Limited, London, England to service the British Air Ministry and airframe manufacturers in the astro compass, instrumentation and navigational system fields.

**PURULATOR PRODUCTS, INC.** has acquired Hadbar, Inc., a Los Angeles producer of gaskets and seals for the missile and aircraft industries.

**WEBB & KNAPP** will build an Aviation and Space Industry Center in Washington, D.C. The two buildings, with 500,000 sq. ft. of floor space, will be ready for occupancy in the fall of 1963.

**BRITISH AIRCRAFT CORP.** says it is looking forward to a substantial order for its Vickers *Vigilant* from the British Army. BAC also is setting up a requested *Vigilant* demonstration for the U.S. Marine Corps which will take place next May.

With the German *Cobra* design reportedly abandoned, the chief competition for the wire-guided *Vigilant* is the French *Entac*, also wire guided. *Entac* is considerably cheaper per round than *Vigilant*, but BAC maintains that it can do twice the battlefield job.

## Financial Reports

| COMPANY                          | PERIOD         | INCOME        |               | EARNINGS     |              |
|----------------------------------|----------------|---------------|---------------|--------------|--------------|
|                                  |                | 1961          | 1960          | 1961         | 1960         |
| American Potash & Chemical Corp. | 9 Mo. Sept. 30 | \$ 33,858,963 | \$ 38,250,153 | \$ 3,160,162 | \$ 3,745,192 |
| E. Goodrich Co.                  | 9 Mo. Sept. 30 | 559,690,620   | 587,602,200   | 23,077,760   | 24,121,747   |
| White Corp.                      | 9 Mo. Sept. 30 | 67,777,288    | 73,097,662    | —            | —            |
| Ortel Co.                        | 9 Mo. Sept. 30 | 22,942,153    | 24,587,295    | 450,368      | -28,774      |
| International Rectifier Corp.    | 3 Mo. Sept. 30 | 3,529,631     | 3,337,496     | 285,080      | 280,667      |
| Ion Industries                   | Year, July 31  | 250,114,456   | 187,761,242   | 10,158,323   | 7,454,854    |
| Lukheed Aircraft Corp.           | 9 Mo. Sept. 30 | 995,442,000   | 962,298,000   | 16,502,000   | —            |
| Cal Electronics Corp.            | 6 Mo. Sept. 30 | 19,238,000    | 18,000,000    | 762,700      | 612,000      |
| Log Servocontrols, Inc.          | 3 Mo. Sept. 30 | 2,564,688     | 1,880,485     | 29,075       | -131,223     |
| Varola, Inc.                     | 9 Mo. Sept. 30 | 207,703,769   | 224,480,543   | 6,416,892    | 9,782,851    |
| National Research Corp.          | 9 Mo. Sept. 30 | 7,404,300     | 6,871,400     | 353,400      | 170,300      |
| Whitrop Corp.                    | Year, July 30  | 267,454,965   | 233,679,427   | 8,673,321    | 7,740,219    |
| Enders Associates, Inc.          | Year, July 31  | 21,385,839    | 17,479,495    | 879,849      | 458,186      |
| Zo Manufacturing Co.             | 6 Mo. Sept 30  | 3,814,074     | 2,548,183     | 185,405      | 76,363       |

missiles and rockets, November 6, 1961

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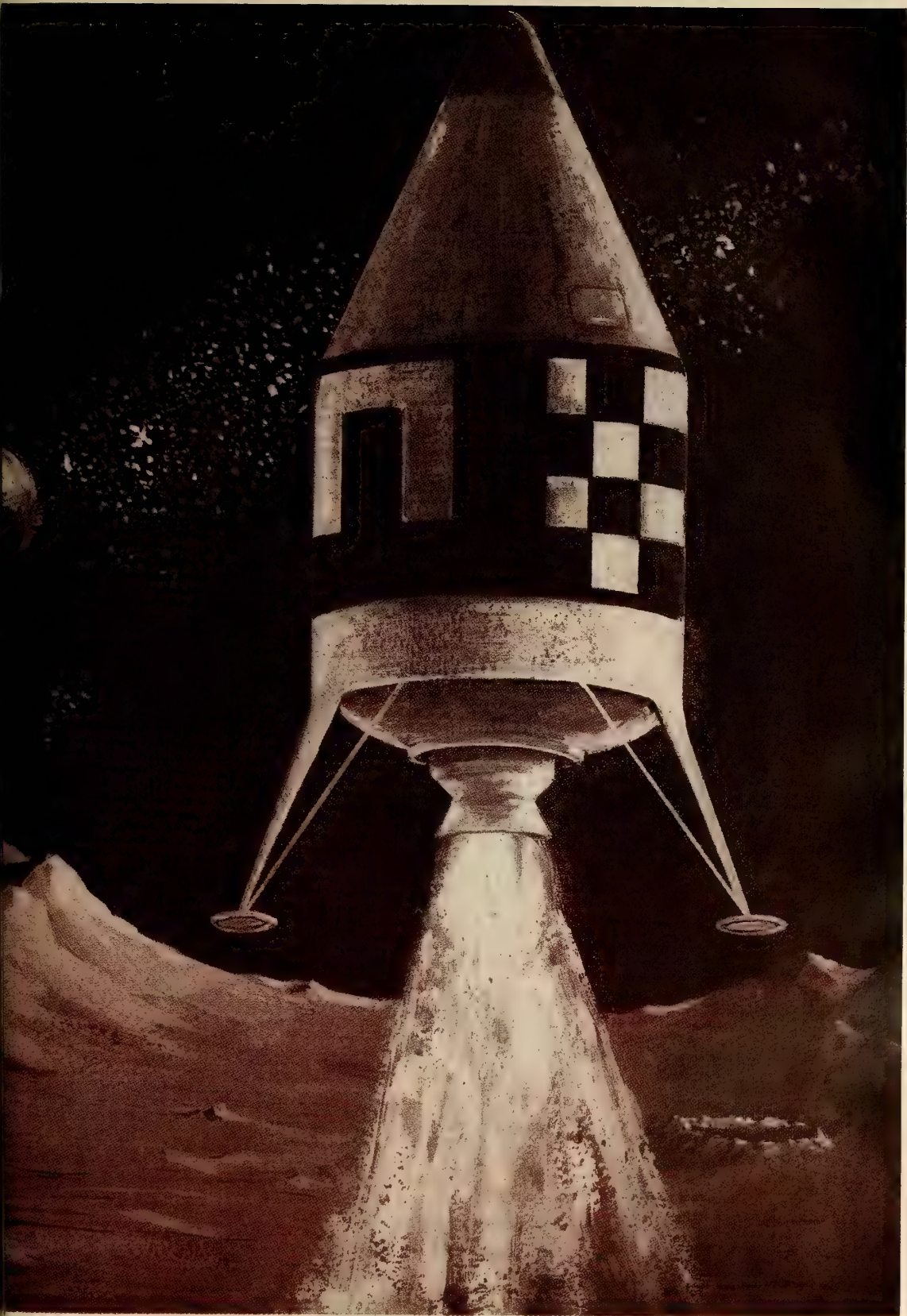
**THE PRESRAY CORP.**  
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november 27, 1961

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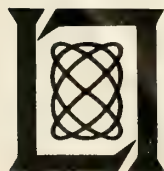
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—names in the news



**MOCK**



**BRITE**

**Richard M. Mock:** Elected to the Board of Directors of Astrodata, Inc., Anaheim, Calif. Mock, a director and member of the Executive Committee of Lear, Inc., has also served as executive vice president and president, a post he held until 1959.

**Lawrence J. Stein:** Appointed Sales Engineer of San Fernando Valley and Central California area for American Drill Bushing Co. Stein has been with American Drill Bushing for three years prior to this appointment.

**Allen S. Clarke:** Elected to the board of directors of the Weinschel Engineering Co. of Kensington, Md. Clarke, former president of Nems-Clarke Co., a division of Vitro Corp., will also act as a consultant to the company. He is on the board of directors of Rixon Electronics Inc. and is chairman of the board of Communication Electronics, Inc.

**Leigh A. Brite:** Formerly with the Aeronutronic Division of Ford Motor Co. has been named vice president in charge of the Technical Products Div., Packard Bell Electronics, Los Angeles, Calif. Brite entered the electronic field in 1946 as research and development engineer with the Army Security Agency and has since been associated with the Transmitter Equipment Co., Goodyear Aircraft Aerophysics Department, and the Hughes Aircraft Co.

**Leland A. Sidwell:** Appointed vice president and manager of the Connector Division of Microdot Inc. Formerly production manager of the Aeronautical Instrument Division of Robertshaw Fulton Controls Co., Sidwell joined Microdot in 1958 as manager of the Connector Division.

**Paul Ignacz:** A native Hungarian sponsored into the U.S. by the National Academy of Science, has been appointed director of research at the Micro Electronic Corp. of Denver, Colo. He is a graduate of the Nador Technical University and has served as research engineer for the Hungarian Institute of Electro Chemistry.

**Robert F. Hurt:** Elected president of Grand Central Rocket Co., he succeeded **Burt C. Monesmith**, vice president of Lockheed Aircraft Corp. Prior to his appointment last June to the post of vice

missiles and rockets, November 6, 196





SIDWELL



LAMPMAN

resident-operations of Grand Central Rocket, Hurt served for ten years with the Lockheed-California Co. in various chief engineering posts.

**Rear Adm., USN (Ret.) Leland R. Lampman:** Appointed manager for *Dyna-* program administration, in the Systems Division of Electro-Mechanical Research, Inc. Mr. Lampman, a 1927 graduate of the Naval Academy, joined the Bendix Products Division as contracts administrator upon his retirement after thirty years active duty, and worked with Defense Electronic Products Division of RCA before returning to Bendix Products Division as assistant marketing manager.

**S. E. Weaver:** Appointed vice president, Engineering and Marketing, The Marquardt Corp. He joined the company last year as vice president, Marketing. Weaver, in addition to his corporate engineering responsibilities, will have cognizance over company-sponsored research and development, product reliability, quality control, and engineering and corporate market research and product evaluation and assignment.

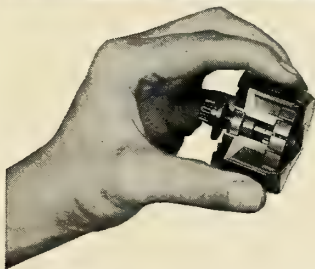
**Dr. Thomas B. Warren:** Former Senior Scientist at IIT Laboratories, has been named Research Director of Micro State's Microwave Components Division, where he will be responsible for expanding research activities in microwave solid state devices.

**James J. Jenks, Jr.:** Elected to Board of directors of the Hewlett-Packard Co. Jenks is chairman of the board of directors of the Sanborn Co., Waltham, Mass., a recently-acquired subsidiary of Hewlett-Packard. **Erskine N. White,** president of the New England Telephone and Telegraph Co., has also been elected to the Board of directors of Hewlett-Packard.

**J. Donald Rauth:** Martin Company vice president, has been appointed head of the *Titan* project. He will supervise research and development, production, flight testing, base activation and final checkout and delivery of all *Titan* missile and space booster systems. Existing responsibilities in the direction of Martin's manufacturing and flight test division involving the *Titan* program will be unchanged.



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Actual test data taken on a group of these gyros demonstrate the capability of this device as the most accurate and stable control gyro now available. Typical test results include the following average values:

Uncompensated mass unbalance level— $0.35^\circ/\text{hr/g}$  avg.;  
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0.017% avg. proportional from  $0.1^\circ/\text{sec}$  to  $5^\circ/\text{sec}$ .

### TYPICAL CHARACTERISTICS

|                                             |                          |
|---------------------------------------------|--------------------------|
| Angular momentum (gm cm <sup>2</sup> /sec.) | 100,000                  |
| Operating temperature                       | 180°F*                   |
| Torquer scale factor (°/hr/ma)              | 800                      |
| Input angle                                 | Up to 30 degrees         |
| Transfer function (mv/mr)                   | 3.75 at gyro gain of 3.0 |
| Dimensions: lengths                         | 3.56"                    |
| body diameter                               | 1.98"                    |
| mounting diameter                           | 2.15"                    |
| Weight                                      | 1.2 pounds               |

\*lower operating temperature as required

Write for complete data



**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

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## Red A-Tests

(Continued from page 1)

beginning Sept. 1, a total of nearly 10 megatons. That is more than half as much as the total reported to have been detonated by all of the world's nuclear powers between 1945 and this year.

The Soviet tests ranged from relatively few kilotons to the giant Oct. 27 blast that was reported by the AEC to be more than 50 megatons.

The bulk of the reported tests—27—were conducted at the Soviet Arctic test range near the big island of Novaya Zemlya that lies between the Barents and Kara Seas. Six of the tests ranging to more than several megatons were conducted in a remote section of Kazakhstan near Semipalatinsk. One test was conducted east of Stalingrad.

At a number of points in the series the Russians were conducting two tests a day sometimes within only a few hours of each other. All were conducted in the atmosphere. One was conducted underwater.

Unquestionably the underwater test was among the most significant. It was reported as a "low yield" blast near Novaya Zemlya on Oct. 23. This was considered to be the warhead for either an ASW missile or depth charge or both.

• **Anti-missile tests**—Other "low yield" and possibly some high yield blasts in the atmosphere were considered to be tests of anti-missile weapons of one type or another.

These are of particular significance. The testing of anti-missile warheads has been cited many times as reason enough alone for the resumption of nuclear tests in the atmosphere.

Thus, as the magnitude of the Soviet tests become more apparent, political demands for U.S. resumption are continuing to grow.

As the week ended, President Kennedy held more high level meetings in which resumption was debated and an affirmative decision appeared to be imminent despite arguments from some advisers and officials that the United States should still seek a new moratorium.

It became increasingly difficult to brush aside the warning given more than a year ago by AEC Commissioner Robert E. Wilson:

"The foreseeable improvements in these different types of weapons are of such importance that any country which decides to proceed with further testing and, hence, a systematic weapons improvement program while we continue to observe a moratorium, is likely in a few years to take our place as the foremost nuclear power in the world."



# contracts

## AIR FORCE

\$5,700,000—General Electric Co., Philadelphia, Pa., for work on a classified Air Force project.

\$17,600,000—Arma Div., American Bosch Arma Corp., Garden City, N.Y., for incentive contract for additional inertial guidance systems for the AF Atlas ICBM. The company anticipates payment of approximately \$3,800,000 to subcontractors and suppliers.

\$7,852,000—Morrison-Knudsen and Paul Hardeman, Inc., Los Angeles, Calif., Construction of Titan missile launch facilities near Little Rock AFB, Ark.

\$2,000,000—General Electric Co., Syracuse, N.Y., a letter contract for precision trajectory measurement system and supporting equipment (MISTRAM-Eleuthera).

\$328,978—Lockheed Aircraft Corp., Sunnyvale, Calif., for work on a classified Air Force project.

\$66,000—Virginia Engineering Co., Inc., Newport News, Va., Polaris training building, Fleet AntiAir Warfare Training Center, Dam Neck, Va.

\$00,000—Sylvania Electric Products Inc., Data Systems Operations Div., New York, N.Y., for study of space flight simulation.

\$0,000—Hughes Aircraft Co., Flight Test Division, Culver City, Calif., four airborne recording units to monitor the operation of F-102 interceptor armament control

systems during test firings of GAR-11 Falcon air-to-air guided missile.

ITT Federal Laboratories, Nutley, N.J., received a contract from Patrick AFB for a semi-automated receiving system to detect and analyze electro-magnetic radiation to protect against the possibility of extraneous radiation causing a launching failure. No amount disclosed.

Aerolab Development Co., Pasadena, Calif., a subsidiary of Marshall Industries, from Cambridge Research Laboratories for Argo D-4 rocket vehicles. No amount disclosed.

Geophysics Corp. of America, Bedford, Mass., for development of ground-based optical techniques for detecting nuclear explosions in space. No amount disclosed.

## ARMY

\$13,000,000—Convair, Div. of General Dynamics Corp., Pomona, Calif., initial development of Mauler guided missile system.

\$357,583—Raytheon Co., Lexington, Mass., modification kits for Hawk missile systems.

\$257,890—Douglas Aircraft Co., Santa Monica, Calif., field change kits and repair parts for Nike/Ajax, Hercules (2 contracts).

\$252,524—Emerson Electric Mfg. Co., St. Louis, Mo., for product and production engineering and quality assurance services

to be performed on XM51 Little John Rocket, less warhead.

\$132,170—Sperry Rand Corp., Sperry Utah Co. Div., Salt Lake City, Utah, for ground handling and test equipment for Sergeant Missile (2 contracts).

\$90,000—Radioplane, Div. of Northrop, Van Nuys, Calif., for ground tracking station for target missiles.

## NAVY

\$4,228,932—Bridgeport Brass Co., Riverside, Calif., for parts for rocket motors.

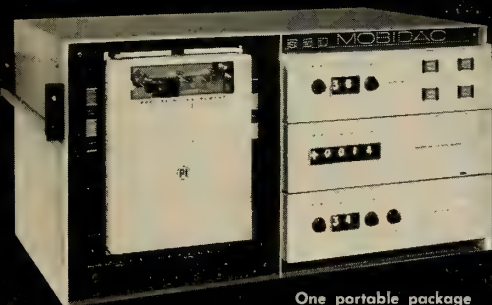
\$2,901,672—General Electric Co., Utica, New York, for additional guidance control equipment for Navy Sidewinder air-to-air missiles.

\$370,000—Howard Engineering Co., Washington, D.C., for system design and coordination for installation of Polaris missile submarine crew training facilities.

\$240,230—Mink-Dayton, Inc., Dayton, Ohio, for nose section, center section, aft section containers, Bullpup missile and pallets.

\$71,412—Amelco, Inc., Los Angeles, Calif., for design and fabrication of electronics assemblies to be used in the NASA S-17 Satellite.

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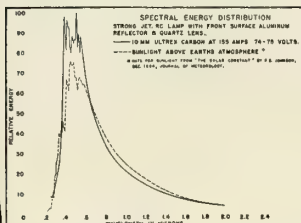
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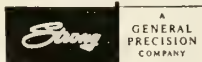


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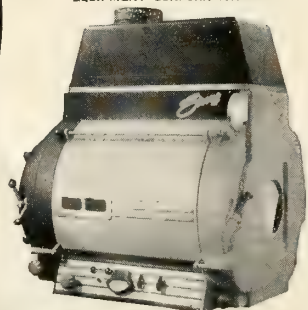
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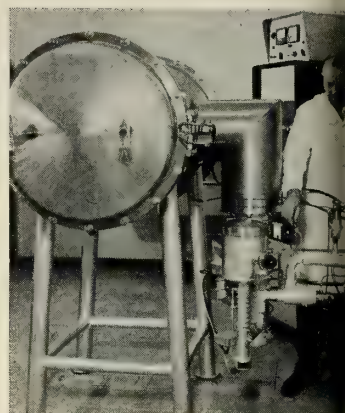
## products and processes

### New Product of the Week: Ultrahigh Vacuum System

Ilikon Corp. is marketing an ultrahigh vacuum system capable of an ultimate pressure of  $1 \times 10^{-10}$  mm Hg. and maintaining this pressure over a period of several days without the use of liquid helium. A pressure in the  $10^{-9}$  mm Hg. range can be attained within four hours of pumpdown initiation and the lower range reached within eight hours.

All gages and feedthroughs are located on the hinged doors, leaving and unobstructed work area 30 in. wide and 50 in. long. Interlocked controls protect the system from power failure, water failure and faulty start-up. All instrumentation is located in a desk-type console.

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### D-C Power Supply

Sola Electric Co. has available a transistorized static-magnetic d-c power supply. The unit has continuous, reliable voltage regulation with outstanding operating efficiency for shunt-type regulation. It is short-circuit-proof because it utilizes a constant voltage transformer. In the event of an open in the transistor circuitry, the transistors lose their base bias and the unit reverts to a mode of operation similar to a conventional static-magnetic constant voltage d-c power supply.

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### Impact Noise Analyzer

A new version of the impact noise analyzer, Type 1556-B, is available from General Radio Co. The latest model adds a push button for resetting the signal storage circuit. In operation, the peak value of an electrical pulse is measured and stored so that an indicating motor can show the peak, even for a single pulse whose duration is only a few tens of microseconds. Since the

stored signal must be erased before another pulse is measured, substitution of the push button for a rotary switch simplifies resetting. Connected to the output of a sound-level meter, the analyzer evaluates the characteristics of impact type sounds—providing a measurement of the amplitudes of steep-waveform pulses resulting from impact noise.

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### PCM/Video Ground System

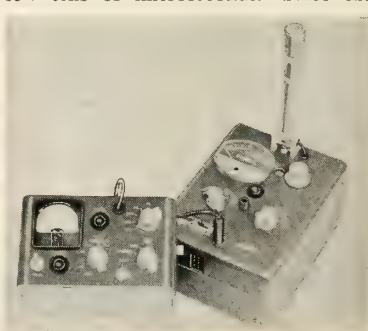
A solid-state PCM/Video quick look ground system for automatic reduction of serial digital telemetered data from missiles and aircraft either during ground checkout or in flight is available from Monitor Systems, Inc., a subsidiary of Epsco, Inc. The Model 825 system monitors up to 202 PCM signals and provides optimum data transmission and synchronization even in the presence of severe noise. Maximum transmission of data is achieved within available bandwidth through the use of optimum response PCM filters. Automatic tracking circuits vary the internal clock frequency to follow changes in the incoming bit rate.

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### Micron Cartridge Filter

A Microtube Cartridge Filter which removes all particles larger than 1 micron from fluids in high-tolerance missile and aircraft recirculating systems is available from Millipore Filter Corp.

The cartridge conforms to the envelope dimensions of AN-6235-D elements for use in Type AN-6234-4 and MS-28720-12 housings. It may be used



missiles and rockets, November 6, 1964



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| Type      | Length and Diameter (inches) | Weight Loaded (pounds) | Total Impulse (sea-level) (lb sec) |
|-----------|------------------------------|------------------------|------------------------------------|
| Miniature | 5.3 x 1.0                    | 0.3                    | 14                                 |
| PIKI I    | 15.8 x 4.4                   | 16.9                   | 1,115                              |
| JUDI I    | 66.0 x 3.0                   | 23.8                   | 3,900                              |
| PIMA I    | 33.4 x 5.6                   | 48.8                   | 6,030                              |
| HOPI I    | 80.4 x 4.5                   | 74.4                   | 11,900                             |
| KISHA I   | 72.1 x 6.5                   | 145.0                  | 21,300                             |
| KIVA I    | 106.7 x 6.5                  | 216.0                  | 33,500                             |
| GILA III  | 101.6 x 9.0                  | 396.0                  | 65,500                             |

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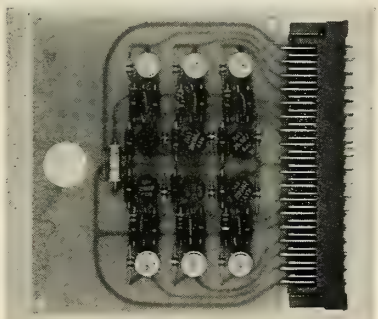
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stalled directly in existing ground-support and test equipment with little or no alteration of system design. Rated flow is 4 gpm at 40 psi diff. pressure (MIL-H-5606A hydraulic fluid at 80°F, viscosity 84 sus.). Maximum operating pressure is 200 psi diff. pressure.

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### Plug-In Card

Computer Logic Corp. is marketing a CD-1 plug-in card. The CD-1 is a high-power, 200-kc clock driver circuit for digital electronic systems. It is also useful for driving medium power in-



dicator lamps or relays. Each CD-1 card contains six independent circuits. Properly connected, the CD-1 can be used to increase the output power level from other computer logic cards.

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### Plating Power Packs

Two power packs specially designed for "table-top" electroplating are available from Selectrons, Ltd. With these additions to its standard model 2530, the company now offers sizes ranging from a lightweight portable unit to a large production model permitting simultaneous plating by two operators. When used with special styluses and non-toxic metallo-organic solutions, the power pack permits quick, controlled electroplating on specific, defined areas. A wide variety of metals and alloys may be deposited on almost any conducting material. Components can be plated on the spot.

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Synthane Corporation is producing a new copper-clad laminate for printed circuitry which meets or exceeds NEMA and MIL specs for room temperature peel strength. The new material delivers a peel strength of 9 to 11 pounds per inch of width at room temperature; and 2 to 4 pounds per inch of width at 500°F., using 2-oz. copper foil, measured on 1/16 in. and 1/8 in. widths, as compared to the usual 0.1 to 0.2 pounds per inch of width.

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Cut-away sections above illustrate reduction of char depth by utilizing Fiberite molding material.

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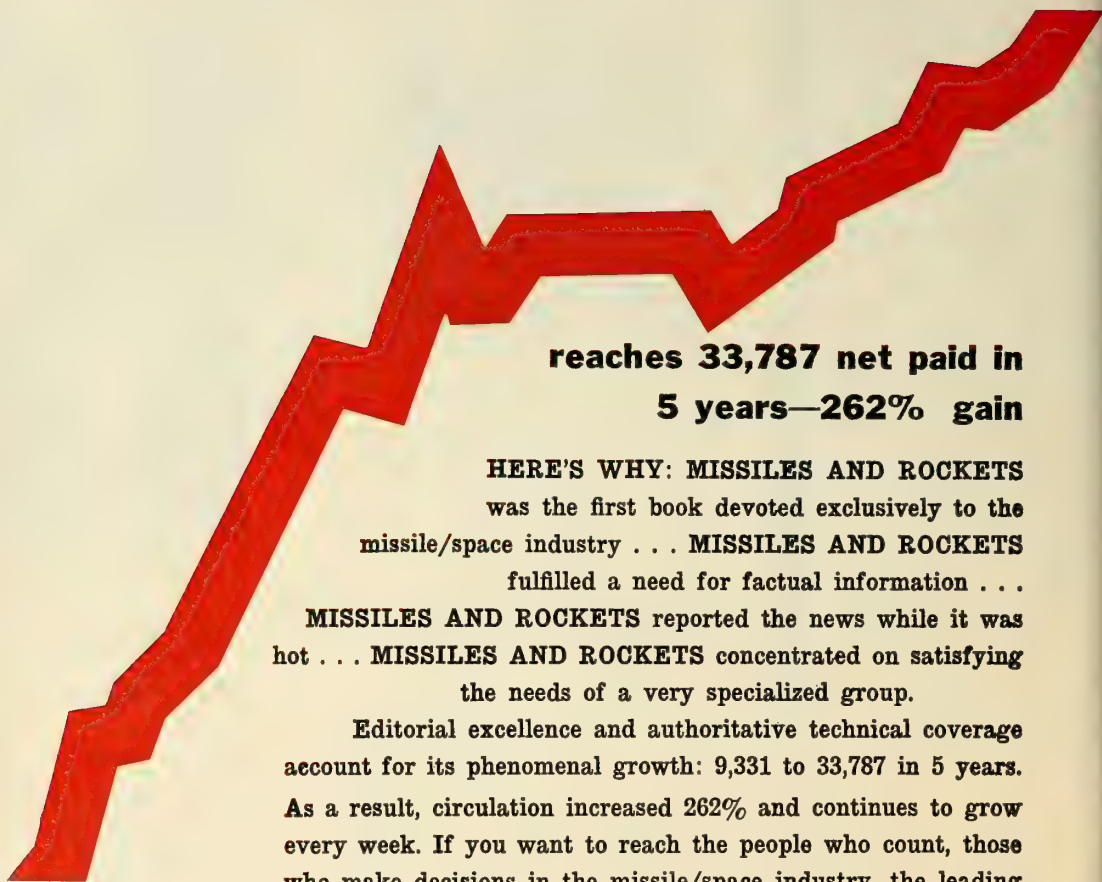
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## —when and where—

### NOVEMBER

**Seventh Annual International Conference on Magnetism and Magnetic Materials, sponsored by IRE, AIEE, ONR and AIME, Thunderbird Room, Westward Ho Hotel, Phoenix, Nov. 13-16.**

**Electronic Systems Reliability Symposium, sponsored by Kansas City IRE, Hotel Phillips, Nov. 14.**

**National Society of Aerospace Materials and Process Engineers (SAMPE) Ceramics and Cermets, Bodies and Coating Symposium, Biltmore Hotel, Dayton, Nov. 14-15.**

**Northeast Research and Engineering Meeting IRE, Somerset Hotel and Commonwealth Armory, Boston, Nov. 14-16.**

**19th Annual Aerospace Electrical Society Display, Pan Pacific Auditorium, Los Angeles, Nov. 15-17.**

**First Conference on Medical and Biological Problems in Space Flight, Bahamas Conferences, Nassau, Nov. 19-24.**

**Electron Devices Meeting, IRE, Shoreham Hotel, Washington, D.C. Nov. 20-21.**

**11th Semi-annual Meeting and Midyear Conference of the Manufacturing Chemists' Association, Inc., New York City, Nov. 21.**

**ASME Winter Annual Meeting, Statler Hilton Hotel, New York City, Nov. 26-Dec. 1.**

### DECEMBER

**Annual International Visual Communications Congress, co-sponsored by Society of Reproduction Engineers, American Institute for Design and Drafting and the American Records Management Association, Biltmore Hotel, Los Angeles, Dec. 2-5.**

**National Aerospace Support and Operations Meeting, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Dec. 4-6.**

**19th Annual Electric Furnace Conference, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.**

**Eastern Joint Computer Conference, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C. Dec. 12-14.**

**Annual Meeting, American Association for Advancement of Science, Denver, Dec. 26-31.**

**Annual Meeting, American Statistical Association, Roosevelt Hotel, New York, Dec. 27-30.**

### JANUARY

**8th National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.**

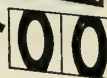
**National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.**

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# Afterthoughts of a Saturnalia

**P**ERHAPS we are getting too cynical these days, but the orgy of self-congratulation which followed the very successful *Saturn* shot seemed to us to have an odd, and almost un-American, note to it. We built something and it worked. Hurrah.

Break out the champagne and alert the editorial writers. For once, some lout didn't leave a two-by-four in the fuel tank. For once, nobody pushed the wrong button to tear the umbilical out before launch. For once, careless bits of solder didn't foul up an electrical circuit. For once, cornercutting by a shoddy transistor manufacturer didn't spoil the electronics. Then, by all means, pour some champagne.

We can remember far back to the day when America built something and expected it to work the first time. Frequently, we were surprised. But we always *expected* it to work.

Now, it seems, everything is reversed. We expect the worst. What heavenly bliss, what delight and astonishment, when we are proven wrong.

"This will do wonders for morale," someone said to us after the successful firing. Is morale really that bad? Have we really fallen that low?

The efforts at delusion following the *Saturn* shot suggest it may be true. Once again came the comforting statements, the soothing pap in the editorial columns. What, one might ask, have the Russians done comparable to this?

The Russians, friend, are banging big boosters into the Pacific like a country hick at a state fair shooting gallery.

We have launched one *Saturn* "over the beach and into the water," where it promptly sank into the depths of the Atlantic and there remains. Sometime next year, with luck, we may launch two more.

This is not intended to detract in any way from the very fine accomplishment of the team which designed and built the *Saturn* and can take rightful pride in a successful first shot. It is an effort to introduce a note of sanity into over-enthusiasm which could soften our space effort. There remains much to be done.

The cynicism of our viewpoint perhaps stems from another event which took place late in the day of the sparkling *Saturn* launch.

Perhaps you missed it. Defense Secretary Robert McNamara announced that the \$85-million in additional funds voted by Congress for the *Dyna-Soar* program would be impounded by the Administration. As expected, this and the accompanying announcement on impounding of B-52 and B-70 funds, got only a small play in the newspapers compared to the banner headlines for *Saturn*.

In the light of the callous wisdom of the Kennedy Administration in its press relations, the timing of this announcement strikes us as more than mere coincidence.

What better occasion for it than in the shadow of the soothing news from Cape Canaveral? All is well in the space race, citizens, back to your fallout shelters.

All is well, nonsense! This nation stands in dire peril of a Russian military threat in space and is doing almighty little about it. Unless there is some realization on the part of the Administration that a strong U.S. military space program is required, we will all too soon find the Soviet Union in a dominant position we cannot match.

**G**EN. BERNARD SCHRIEVER and other farsighted Pentagon military personnel have gone about as far as they can go in pushing the Air Force fight for an effective military space program—without risk of court-martial.

The *Dyna-Soar* program stands at the moment as the fastest route for putting a U.S. military man in space. It should have available to it every dollar needed. Other Air Force space programs also require funding.

This is a period in which we should be putting more money into these programs, not withholding funds which the Congress has appropriated.

This magazine has insisted for more than two years now that the U.S. activate an effective military space program, that the Air Force is the logical service to carry the major burden of such a program, and that this nation is in danger if such action is not taken.

Both the previous Administration and the present one have failed to react to the Soviet threat. The Kennedy Administration has done more than its predecessor to bolster the U.S. space program, far more. But while the effort to step up the lunar program is commendable, the emphasis has been almost entirely civilian, to the detriment of the military.

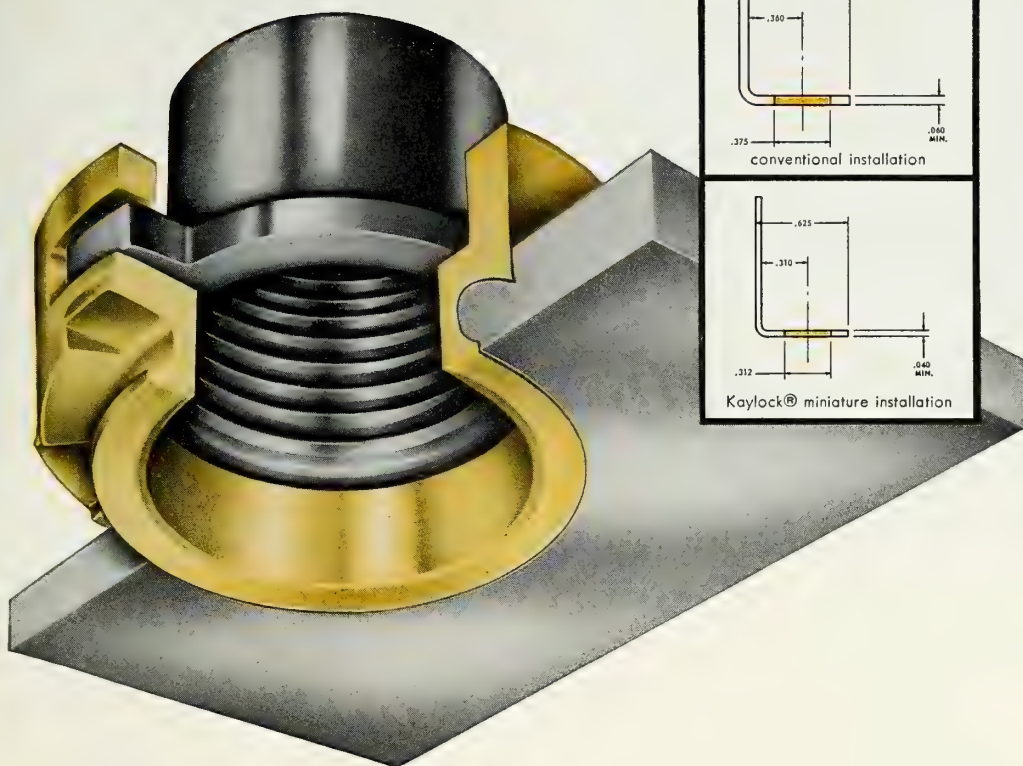
We should not be ashamed to activate a major military program to dominate space and to tell the world about it.

"Space power is peace power," is the way Gen. Schriever put it and the good Lord help us if we don't heed his words.

Because we certainly won't be able to help ourselves.

William J. Coughlin





## To mistaking Kaynar's new stake nut—it's miniaturized

The new Kaylock® Miniature Stake Nuts bear the unmistakable mark of Kaynar's leadership in aerospace fastener weight and space savings. These new miniatures answer the critical need for installed reliability of threaded elements in minimum thickness materials...can save you up to 33% of hardware weight. Additional savings can accrue as a result of thinner parent material requirements (.030 minimum thickness for Kaylock Non-Floating Stake Nuts, .010 minimum for Floating Stake Nuts.)

**Easier and Quicker to Install.** No flaring of the nut shank is required. The pressure used in installation results in a cold flow of the parent material. This interlock of the nut and the mating material, in a smaller installation hole, provides greater structural integrity. Staking action of the Kaylock self-locking nut provides maximum retention against push-out and torque-out. The new series is available in miniature and regular configurations, both floating and non-floating. Write today for the new Kaylock Stake Nut Brochure, or contact your Kaynar representative.



MF 7200 floating miniature



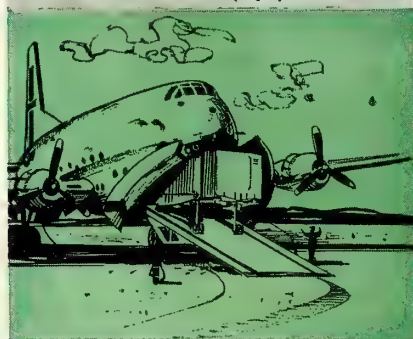
MK 7200 non-floating miniature

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THE MISSILE/SPACE WEEKLY



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mixes propellant for

# POLARIS

## Two outstanding examples of special applications for critical dispersion efficiency

To meet the challenge of producing space-age fuels in big volume for missiles and rockets (including the great Polaris) Aerojet General Corp. engineers have recently completed a change from batch-type mixing to the first continuous process for propellants.

Under their direction Cowles dispersing specialists adapted a giant "COWLES DISSOLVER" to the highly critical operations involved, with noteworthy advantages.

1. *Big volume fuel production for large missiles and rockets became practical for first time.*
2. *Labor costs were cut 80%.*
3. *Fire and explosion hazards were greatly reduced.*
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Because the "COWLES DISSOLVER" provided the best pattern of dispersing materials and compounds to fine particle size in the shortest possible time, six of the largest types were specially designed for the Callery Chemical Company plant (see illustration). Close cooperation between Callery engineers and Cowles application specialists led from a two-stage operation to a

single-step method combining the dispersion and reaction stages.

### Unique features offer exotic fuel advantages

Cowles dissolving begins where conventional mixing stops. The patented Cowles impeller imparts high velocity to materials, creating intense turbulence and producing multi-phase, multi-directional action and hydraulic attrition between the particles. The exclusive M P D\* (Maximum Power Delivery) drive is capable of delivering up to 90% of motor horsepower to the impeller, even at slowest speeds.

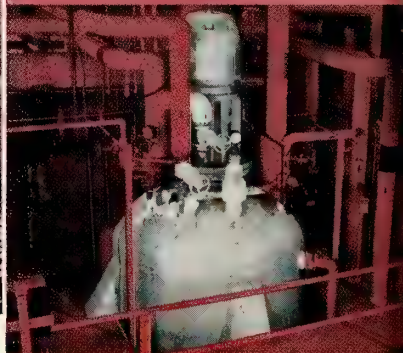
Completely homogenous metallic dispersions to particle size as small as two microns are finished in a fraction of the time required by ordinary equipment... and for many reactions under conditions previously considered impossible.

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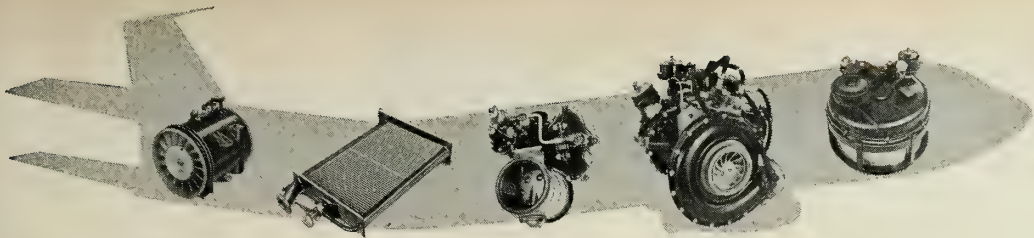
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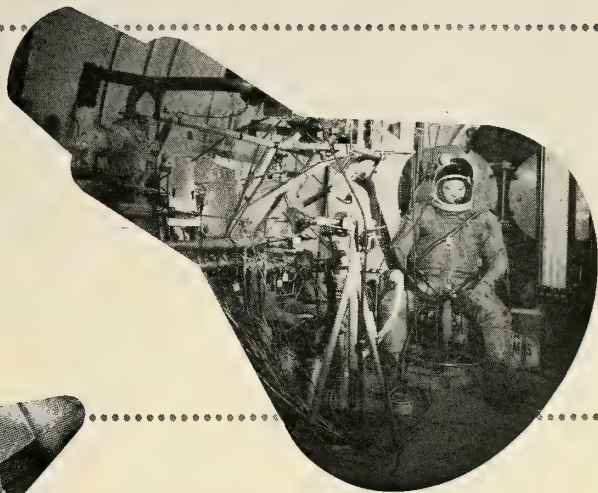
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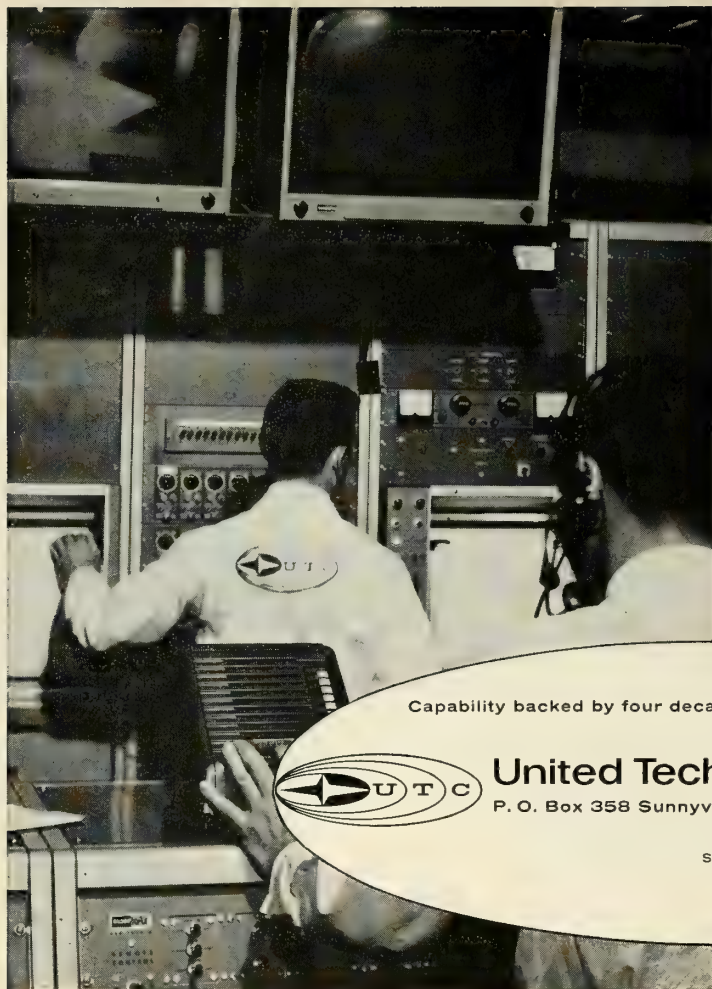
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Left—The scene: UTC Development Center. The action: static firing test is monitored on closed-circuit TV in Remote Control and Data Acquisition Center.

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# missiles and rockets

Volume 9, Number 20

November 13, 1961

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## THE COVER

Mark W. Cresap, Jr., president of Westing-  
house, and E. V. Huggins (right), vice presi-  
dent and director of defense operations, in-  
spect firm's Baltimore Divisions. See p. 12.



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## letters

### Stratoscope and OAO

To the Editor:

The article "Stratoscope II to Give Clearest Look at Heavens" (M/R, Oct. 2, p. 28) was very interesting.

Certain of your comparisons between the performance expected from *Stratoscope II* and satellites such as the *Orbital Astronomical Observatory* were incorrect, however.

Balloon-hoisted telescopes do have the advantages, compared with satellite observatories, of low cost and possible high weight of payload.

Satellite observations can be stabilized just as well, however, and probably better than balloon-hoisted observatories. Thus, satellite observatories can get as good or better resolution photographs.

Your article states that "one of the advantages (for *Stratoscope II*) not easily duplicated by a satellite observatory (is that) an astronomical body can be studied continuously for a relatively long time—up to an hour."

However, the *Orbiting Astronomical Observatory* will be able to observe any star continuously for at least 63 minutes (over an hour).

Barbara K. Lunde

Physicist, Guidance and Control  
Section

NASA's Goddard Space Flight Center  
Greenbelt, Md.

*We are sure that the OAO's will be able to do all of these things—when they are orbited, beginning in 1963. The point is that Stratoscope II is due for launching next summer. The article contrasted Stratoscope II's potential with that of satellites in "today's technology."*—Ed.

### Further on Lunar Craters

To the Editor:

Mr. Benjamin W. Bova's observance of the ray pattern formed by the impact of a *Ranger* capsule from 1000 ft. to a macadam surface (Letters, M/R, Oct. 9, p. 7) may be analogous to, but not entirely like the ray systems formed by explosivity on the lunar surface.

The ray pattern of the *Ranger* capsule impact is entirely radial, whereas lunar formation, notably Copernicus and Tycho, have several tangential rays. The large ray extending from Copernicus and terminating between Timocharis and Lambert lies at an angle of nearly 90° to the moon's equator and a center line drawn through Copernicus parallel to the equator. An explanation of this phenomenon may be that high-velocity ejecta may have been deflected by resisting materials at or around the site of a meteorite impact, or that the faster rotation of the moon in its early history may have formed the tangential rays by Coriolis action during the flight of ejecta.

The lack of a central peak, common to many lunar craters, but absent in the *Ranger* capsule crater, can be explained

by the fact that only specially shaped projectiles form central peaks (so far as we know from laboratory experiments).

The ray systems of certain lunar craters may support their meteoric origin, but to the student of the volcanic origin of the lunar physiography it is doubtful that meteoritic impacts formed all the features of the moonscape. I refer to crater rim peaks with summit pits, internal terracing, polygonalism of crater shapes, domes, meridional alignment of walled plains (from Walter to Ptolemaeus, Furnerius to Langrenus) and concentric craters such as observed in the huge walled plain Boussingault.

Space limits a discussion of these phenomena, but J. E. Spurr's "Geology Applied to Selenology" and V. A. Firsoff's "Strange World of the Moon" should be read by proponents of the meteoritic theory before accepting the popular dogma of the meteoricists.

I should be pleased to see more pictures of ray patterns made by rockets or their components.

Ray Benton

Co-ordinator, Space Research  
Exploratory Research Group  
Melpar, Inc.  
Falls Church, Va.

To the Editor:

In your Oct. 9 issue there was a letter from a Mr. Benjamin Bova which mentioned the puzzle of the moon craters.

I would like to point out that in the August issue of *Scientific American* there was a very interesting article titled "Astroblemes," by Mr. Robert S. Dietz of the Navy Electronics Laboratory in San Diego. The article outlined the possible causes and present appearance of ancient scars left on the earth's crust by huge meteorites.

The "shatter cones" mentioned would, in general, appear to be the same configuration as the "rays" extending from some of the craters on the moon's surface.

Henry Overal

Section Chief, Power Components  
& Packages

National Water Lift Company  
Kalamazoo, Mich.

### Bad TV Picture

To the Editor:

The representation of the Cape Canaveral area on the "Brinkley's Journal" (TV) program of Oct. 11 was most unfortunate and in extremely bad taste. It left a poor impression on a nationwide audience, and an improper one.

At a time when it is increasingly important to our national interest to attract the right kind of people to an area where there will be tremendous growth in the years ahead, this program did more to discourage these persons and attract undesirable elements than could possibly have been done had the program been deliberately compiled to accomplish these goals.

What must the rest of the country think of this Cape Canaveral area and of



the enormous expenditures of their tax dollars on activities here when such irresponsible reporting makes this look like a governmental Coney Island, three-ring circus and Disneyland rolled into one—and at their expense.

Of course there are wasted tax dollars here, as in every governmental undertaking, but these are not subsidizing a playground here as Mr. Brinkley would seem to portray; they are not soaked up as the rains in Florida sand.

An objective, factual, honest survey of ALL facets of life in the Cape area would show the vast—yes, overwhelming—majority of residents to be normal families (look at the growth of schools, shopping centers, churches) who experience the same problems and have the same anxieties as families in almost any other city or town in America.

But we are different here, too. I believe we have a keener awareness of the urgency of the work going on than the nation as a whole. We feel more deeply each advancing step of the Russians in technological progress as we relate this to our known position. This, in turn, kindles a competitive vigor and dedication of purpose to the activities and contributions each of us is making in our own efforts. I believe, too, that we are more sensitive to the meaning of our work, its results, its purpose, its influence on world opinion and reaction, its effect on American prestige than any other collective group in the nation.

George F. Rugge Jr.  
Eau Gallie, Fla.

## Fitting Survey

To the Editor:

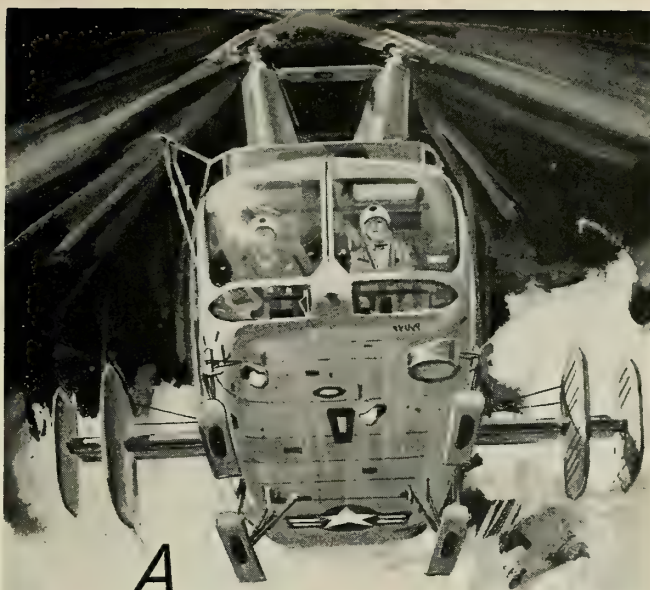
Stanford Research Institute has been designated by Lockheed Aircraft Corp. to survey and evaluate available and potentially available hydraulic and pneumatic fittings.

In particular, on the basis of this survey, we seek to select a suitable tubing fitting for use in missiles and space vehicles. The principal criterion for selection will be the ability to remain helium leak-tight even after exposure to the extreme conditions of ground handling, atmospheric sub-orbital boost and space.

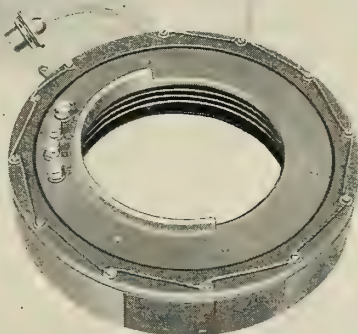
It is our hope that the survey and evaluation will result in the selection of a new fitting to replace the military-standard types in rocket-propelled vehicles. We fully realize that a suitable fitting could be currently in use outside of the missile and aircraft industry, and therefore prior to embarking on a full development program we want to explore all potential areas of availability.

SRI is conducting a general literature survey, contacting all known fitting manufacturers and distributors and following any lead that might result in a new and different type of tubing fitting. We know that reproduction of this letter in your magazine would reach more potential areas throughout the country than all of our survey efforts combined.

Adrien J. Aitken  
Propulsion Sciences Div.  
Stanford Research Institute  
Menlo Park, Calif.



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# The Countdown

## WASHINGTON

### MRBM: Status Report

The best description of the newly-revived MRBM program to date is: Very tentative. The Air Force has won out over the Army and Navy in receiving a DOD go-ahead to start thinking officially about developing some components. But there is no money, no authority to develop missile prototypes, no decision whether the missile would be sea- or land-based, and no determination whether the NATO countries for whom the missile would be developed will buy it.

### Zeus Tests with a Nuclear Punch

One of the hottest reports going the rounds is that President Kennedy soon will announce that *Nike-Zeus* tests in the Pacific next year will involve the use of nuclear warheads. At present, the big Western Electric missile is scheduled to be armed only with HE when it is fired against *Atlases* launched from Vandenberg AFB, Calif. According to various reports, some 12 to 14 nuclear-tipped *Zeus* missiles will be substituted into the test program.

### Golovin Report: Will It Stick?

The long-awaited Golovin Space Booster Report is already facing the possibility of rough treatment. A number of government officials who disagree with the report's conclusions are reported to be preparing counter arguments aimed at preventing the report from being used as the basis for final decisions. One of the principal objections comes from NASA officials who are holding out for the *Saturn C-3* rather than the *C-4* called for by the report.

### Recovering Saturn

Plans now tentatively call for attempting to recover a *Saturn* booster after the fourth or fifth shot in the R&D launching series. Recovery by parachute—rather than the Rogallo-wing concept—is currently looked upon as the best bet.

### Army Pushing for Lead Time Slash

A new drive is being launched by the Army to reduce sharply the lead time needed for development of new weapon systems. One prime feature will be a new system of handling funds to ensure that optimum funding is always possible. This could result in production cuts elsewhere when funding runs low. The goal: Lead times of four years rather than six to eight.

## INDUSTRY

### R&D Intelligence

The Air Force is reported to be looking into ways to triple the range of *Skybolt* even before the first of the 1000-mi. test models is fired . . . *Snap II* with an

output of 2-3 kw will be the power source when NASA tries to fly Electro-Optical Systems and Plasmadyne electrical engines aboard a *Scout*-boosted satellite in late 1963 or 1964 . . . Major snag in the *Apollo* lunar plan still lies in determining what the return propulsion system will be . . . Who Knows Dept. What happened to the West Ford needles?

### New United Move In Space

Following up the establishment two years ago of UTC, United Aircraft is now setting up a Corporate Systems Center at Windsor Locks, Conn. Objective: Development, management and production of space and missile systems.

### Moving Day for Electrical Propulsion

Electrical propulsion research at NASA is to be transferred from the Marshall Space Flight Center in Alabama to the Lewis Research Center in Ohio. The entire program is expected to be expanded considerably.

### Housekeeping Scramble

One of the keenest competitions now in progress is for the housekeeping contract at the big Michoud Arsenal in Louisiana where *Saturn* boosters will be produced. Some 60 companies including a number of the missile/space industry giants are reported to be among the bidders. This may be a new trend in diversification: If you can't build rockets, you can at least serve hot lunches.

## INTERNATIONAL

### France: Tooling Up for Engines

SNECMA is tooling up for the construction of big rocket engines. The equipment is being installed at the company's Gennevilliers plant. Meantime, SNECMA and SEPR are discussing possible cooperation in the manufacture of the big engines.

### Australia: Looking at the Stars

CSIRO—the Commonwealth Scientific and Industrial Research Organization—is putting into operation its huge new radio telescope at Parkes, some 200 miles west of Sydney, Australia. The \$1.8-million telescope is only slightly smaller than the famed radio telescope at Jodrell Bank in England. The Parkes telescope's surface accuracy and control system is considered superior.

### Overseas Pipeline

Italy's new ASW Center at La Spezia is completed . . . A British *Skyhawk* reached an altitude of more than 100 miles at Woomera Nov. 2 in the third of four NASA firings . . . Russia is reported to have a new missile with a range of 2000 miles . . . the FAI is revising its "Sporting Code" covering spaceship record flights.

# The Missile/Space Week

## Justice Scores ComSat Plan

A top Justice Department official declared that an industry proposal for ownership of a communication satellite system did not meet the standards of the Kennedy Administration.

Lee Loevinger, head of the Justice Department's Anti-trust Div., emphasized that dissatisfaction with the proposal was based "mostly on its generalities and omissions."

Loevinger made the statement before a hearing of the Senate Small Business Anti-Monopoly Subcommittee (see p. 14).

He said that the department has not yet taken a stand on details of the plan—which calls for a non-profit corporation to run the system. But in general, he said, the plan was not adequate to meet the requirements set by President Kennedy and the Justice Department.

Loevinger said that one of the areas being studied was the possibility that the plan would give control of the corporation to the American Telephone & Telegraph Co.

Another area needing further study, he said, was one section of the plan which would enable communication carriers to charge off any losses incurred in the system against other segments of their business—including long-distance calls.

## Shots of the Week

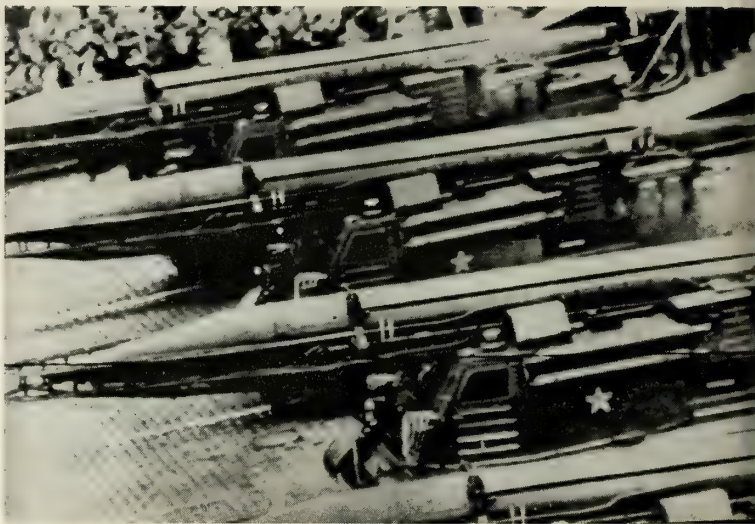
An "in-orbit malfunction" forced the Air Force to abandon plans for attempting a capsule recovery from *Discoverer XXXIV* after it was orbited Nov. 25. Contents of the 300-lb. capsule in the 1700-lb., 25-ft.-long satellite were not disclosed.

In missile firings:

The Ethan Allen conducted its sixth successful firing of a *Polaris* while submerged on Nov. 8. The 1500-mile A-2 reportedly flew its programmed range, the 24th successful shot in 37 submerged *Polaris* firings.

A *Pershing* scored its 21st success in 25 attempts Nov. 2, flying a programmed erratic path in a test of the guidance computer system.

At Jackass Flats, Nev., an explosion in a hydrogen system forced can-



## Latest Red Missile Display

*SOVIET MISSILES* were paraded Nov. 7 on the 44th Anniversary of the Bolshevik revolution. One missile, said to be new, was transported in gasoline-truck-like containers. The T-5's (above) appeared on tracked armored trucks. (UPI Telephoto)

cellation of a full-power run of the Kiwi B-1A reactor Nov. 7. Five men were injured, but the reactor was not damaged.

At Eglin AFB, Fla., a B-52 dropped a dummy *Skybolt* from low altitude. Two others have been dropped from high altitude.

## Reds Join Weather Meeting

Twenty-eight nations are scheduled to attend an International Meteorological Satellite Workshop which will be held in Washington Nov. 13-22.

The Soviet Union—in a surprise move—has announced plans to attend the Workshop co-sponsored by NASA and the U.S. Weather Bureau.

On the first day of the Workshop scientists from both agencies will speak on current weather satellite operations, research results, and plans for the future.

Two days will be spent visiting NASA and Weather Bureau installations including the Goddard Space Flight Center, the data acquisition station at Wallops, Va., the Meteorological Satellite Laboratory and the National Meteorological Center.

In laboratory sessions to be held

on November 17, 20 and 21, the participants will perform many practice exercises using actual *Tiros* observations, both photographs and radiation data.

On the final day of the conference, individuals and small groups will have an opportunity to discuss their special problems with experts from both agencies.

The three *Tiros* satellites which have been launched have taken a total of 70,000 cloud photographs. It is U.S. practice to share this information with other countries of the world.

Countries slated to attend the meeting include Argentina, Brazil, Canada, Formosa, Czechoslovakia, Denmark, El Salvador, Finland, France, West Germany, Honduras, Iran, Ireland, Israel, Italy, Netherlands, Antilles, Nigeria, Pakistan, Norway, Poland, Portugal, Sudan, Thailand, United Arab Republic, United Kingdom, USSR, and the West Indies Federation.

## New Funding Awards

Several major missile and space programs, including *Titan*, *Polaris*, and Project *Advent*, received addi-

missiles and rockets, November 13, 1961



tional Pentagon spending this week.

An award of \$17 million went to Martin's Denver division, for continued development and fabrication of the *Titan* ICBM. Two days earlier, the Air Force spent \$10.9 million with Martin for additional R&D testing of the *Titan II*, already in an advanced development stage.

Contracts totaling \$13.1 million were let for additional work on the *Polaris*. Westinghouse received \$8.1 million for launcher design and development, and a \$5-million contract went to General Electric for missile fire control system production.

Project *Advent*, the Air Force communications satellite program being administered by General Electric, was also awarded a \$4-million supplemental contract.

### NASA Presses Recruiting

NASA has announced that it will visit some 30 cities in its drive to hire some 2000 scientists and engineers by June 30, 1962.

Another 1500 new positions will be filled in administrative and support divisions of the space agency to bring its total employment rolls to well over 21,000.

Administrator James E. Webb noted that the new employees are needed to staff the "lunar program, nuclear propulsion research and development, space science, supersonic transport study and numerous other aeronautical and space technology jobs."

A team of top NASA scientists and officials on one recruiting team visited Chicago last week. Other cities to be visited in the next week include Denver and Phoenix. Other recruiting visits will be announced later.

### 'Space Club' Pact Near

A nine-nation agreement is expected within the next two weeks on the establishment of Europe's "Space Club."

Governments in Britain, France, Australia, Belgium, Denmark, Netherlands, Italy, Spain, and West Germany are weighing approval of a resolution creating the joint organization for the development and construction of space-vehicle launchers for peaceful purposes. The resolution was drawn up at a London confer-

ence which closed Nov. 3. It is still a question whether the three "observer" nations attending the conference,—Norway, Sweden, and Denmark—will decide to participate in the new venture.

Tentative launch schedules, employing much existing hardware and resources to speed initial firings, call for the first three-stage satellite vehicle to be launched from the Woomera range in Australia in 1965. The British *Blue Streak* will be used for the first stage, with France and West Germany providing stages two and three. Initial firing of the *Blue Streak* has been set back to 1963 from a previously scheduled 1962 launch.

Advanced projects are expected to be started soon after the organization becomes operational. A major effort will be made towards development of multipurpose launch vehicles which could orbit an advanced communications satellite. There are no present plans for actual satellite development by the nine-nation group, but approximately \$200 million is expected to be spent over the next five years for launcher development, with the British supplying approxi-

mately one-third of the funds. The actual satellite may be developed by a new organization or purchased from a U.S. or European supplier.

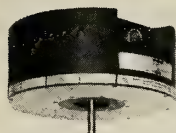
The "Club" will be headed by a council consisting of representatives of all participating governments, with a secretary-general and a technical director responsible to the member groups for the execution of the various programs.

### Red Tests Stop—for Present

Russia touched off its 31st nuclear test explosion—by the AEC's count—on Nov. 4. Premier Khrushchev said more would follow if the U.S. resumed atmospheric tests.

Khrushchev made his statement Nov. 7 after President Kennedy said the U.S. is preparing now for atmospheric tests—if studies show the Soviet series are resulting in military gains.

The Nov. 4 blast was pegged at "several megatons." Two smaller explosions in the low-to-intermediate range were set off in the Novaya Zemlya test area on Nov. 2.



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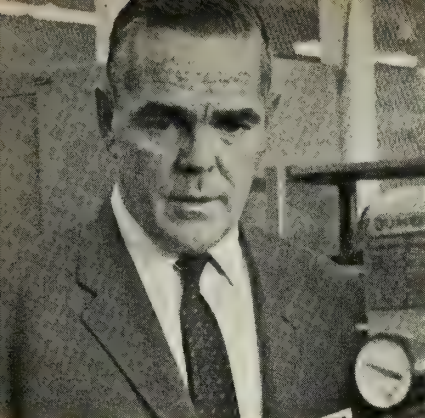
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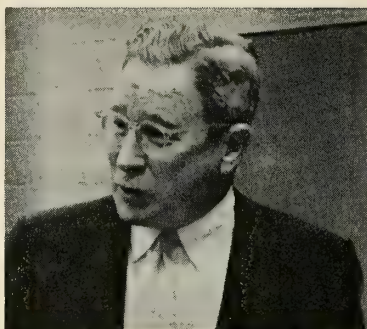
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Mark W. Cresap, Jr.—President of Westinghouse Electric Corporation.



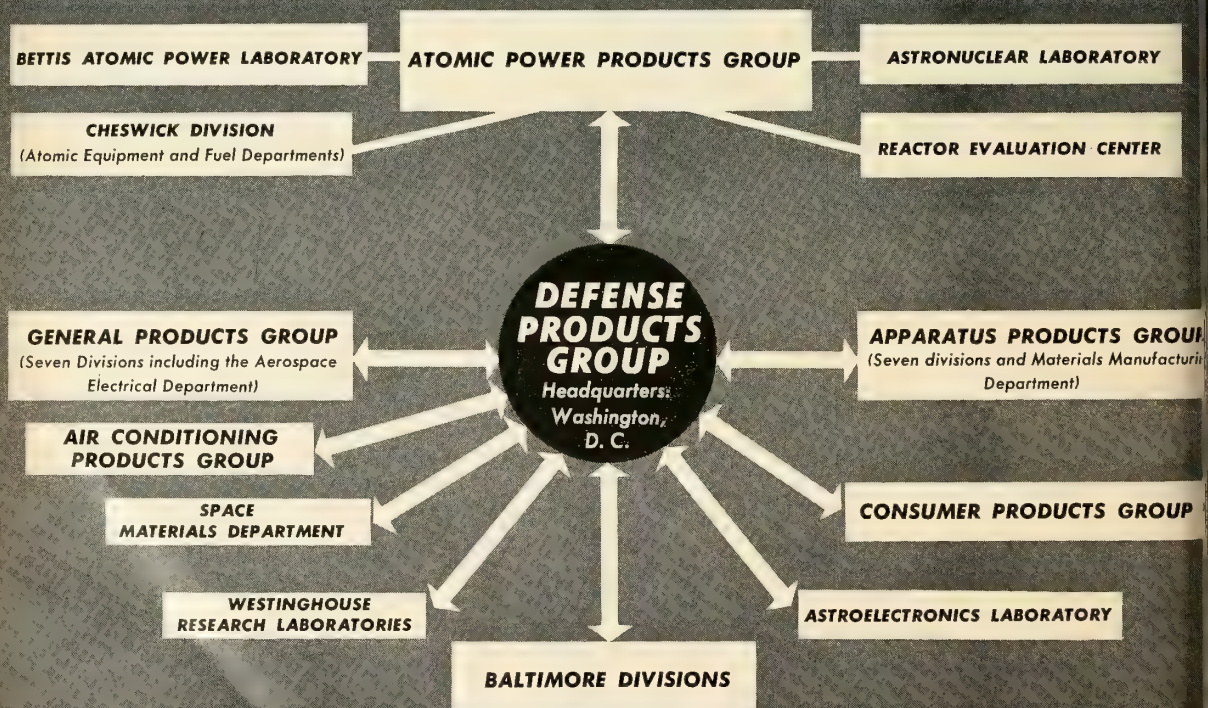
E. V. Huggins—Vice president and director of defense operations.



Maj. Gen. Albert Boyd (USAF-Ret.)—Vice president and gen. mgr.-defense products.

# Electronics Surge: 'Big Ter

*Typical of electronics-based firms expanding their missile/space abilities, firm expects 'very rapid' growth in '63-'66*





by James Baar

# Spot Eyed by Westinghouse

MISSILE and space-based industry is picking up new momentum today amid forecasts that it will reach much greater heights within the next few years.

The lash of requirements from new missile projects and the booming Space Age is forcing further acceleration of the already rapidly moving shift from air frame manufacturing to ever greater expansion and development in advanced areas of electronics, propulsion, power supply and materials.

Of all of these advanced areas the undoubted king-pin is electronics. As NASA Administrator James E. Webb said within the last few days:

"Today approximately 50 cents of every dollar spent for space systems goes into electronics. This ration certainly will not decrease as the accelerated National Space Program advances. . ."

Thus the way is being opened more than ever before for the electronics and propulsion companies to challenge the giant air frame manufacturers for dominant positions in the Missile/Space Industry.

The Big Ten of the Defense Department's List of 100 Prime Contractors already has made room for three electronics firms—General Electric, AT&T and RCA. Others are scrambling up the ladder.

Many of the air frame manufacturers—such as Lockheed, General Dynamics and Martin—are meeting the shift by broadening and reorienting their capabilities. But they find themselves competing in the new areas against firms long established in the field.

As a result, a free-for-all is developing in the market place, and the challengers confronting the Big Ten are making bold advances. Among the foremost are such companies as Westinghouse, Sperry-Rand, Raytheon and General Tire & Rubber.

One look at the Defense Department's List of 100 shows what is happening.

Raytheon has jumped from 22nd in FY '58 to 12th in FY '60. Sperry-Rand jumped from 17th to 13th.

General Tire & Rubber (Aerojet-General) jumped from 26th to 17th.

• **Westinghouse ascends**—One of the most powerful challengers for a place in the Big Ten, itself, is Westinghouse Electric Corp. In many ways, this corporation typifies the accelerated shift under way in the industry.

In FY '57, Westinghouse was 22nd on the List of 100 with \$182.1 million in prime military contracts. In FY '58, Westinghouse was 18th with \$269.3 million in contracts. And in FY '60, Westinghouse climbed to 16th even though the corporation's total prime contracts dropped slightly to \$257.6 million—a climb made possible by the continuing decline in aircraft procurement from air frame manufacturers.

The Defense Department's list for FY '61 has not yet been issued. However, Westinghouse's prime contracts for the year rose to about \$308 million, indicating another jump on the list.

Westinghouse officials feel that this climb has only begun. As Mark W. Cresap, Jr., Westinghouse's driving 51-year-old president, put it recently:

"We have had a plateau of net sales since 1957—about \$1.9 billion to \$2 billion a year. We expect these to begin to rise at a very substantial rate in about another 12 to 18 months. We expect the period 1963 to 1966 to be one of very rapid growth for the corporation."

Cresap sat in a paneled office of the new administrative wing of the Westinghouse Baltimore Divisions. E. V. Huggins, chairman of the corporation executive committee, vice president and director of all Westinghouse defense operations, and Maj. Gen. Albert Boyd (ret.), vice president and general manager of the Westinghouse Defense Products Group, were with him.

They had just completed a periodic meeting with officials of the Baltimore plants and were about to tour the facilities. Among other programs, the Baltimore Divisions handle the nuclear-tipped *Astor* torpedo and

(Continued on page 40)

# Pentagon Revamping Patent License Policy

**Industry will have far greater use of inventions that result from space R&D; ComSat ownership still studied**

THE DEPARTMENT of Defense is making a major change in its patent licensing policy in all space research and development contracts.

The change will permit far more extensive use by American industry of new inventions and devices developed under DOD contracts.

The new move was disclosed at a hearing of the Senate Small Business Anti-Monopoly Subcommittee called to take testimony on the ownership of a commercial communication satellite system.

Kennedy Administration officials declared that no "government-wide" position will be taken until the Federal Communications Commission completes its study of recommendations made by an ad hoc committee of international communication carriers. They indicated, however, that Administration leaders will probably propose changes in the carrier's plan for a non-profit corporation to run the system.

• **Sublicense authority**—The DOD patent policy switch results from a study by the White House's National Aeronautics and Space Council.

Dr. Edward C. Welsh, Executive Secretary of the group, told the congressional committee that although the patent policy dealt principally with communication satellite R&D contracts, DOD had agreed to extend it to all contracts in the space field. It is also probable, informed sources report, that the policy will govern many other DOD contracts in the R&D area.

Under previous DOD policy, the private firm awarded a contract was also given an exclusive license to use any patents developed during its performance.

According to the official language

of the new policy, the contractor will also "grant the government the right to grant sublicenses to others, under such terms and conditions as may be prescribed, for the practice of any subject invention throughout the world in the design, development, manufacture and operation, maintenance and testing of communication satellite systems, and of equipment, components, ground tracking, transmitting and receiving facilities therefor."

In addition, Dr. Welsh told the committee, DOD has advised that such language will be included in all future contracts covering research and development in any field related to space, including space exploration and space communications.

The DOD policy on space patents will now be much closer to the NASA policy. The space agency has proposed, however, it be permitted to charge sublicensees a "fee" for the use of a patent developed by another firm.

• **Ownership evaluation**—As far as the ownership plan for a commercial communication satellite system is concerned, Dr. Welsh said "no definitive administration position can be presented until studies of the ad hoc committee's proposal are completed by government agencies.

"When we do have such an evaluation finished," he continued, "it presumably would take the form of a recommendation to the President."

The carriers' report called for a non-profit corporation to be set up to run the system. Its board of directors would be composed of representatives of the communication carriers contributing funds and using the system, together with three representatives who would be appointed by the President.

Under this plan, American Telephone & Telegraph Co. would contribute about 80% of the costs of the whole system. Government officials believe that this would put AT&T in effective control of its operation. A final government position will not be decided until after the FCC holds a public hearing in which sworn testimony will be taken from witnesses representing all sides of the thorny issue.

• **Plans afoot**—Meanwhile, there were these other developments in the communication satellite field:

—Radio Corporation of America declared that a communication satellite capable of relaying television programs directly to home receivers is now feasible.

—Lockheed Missiles & Space Co. has proposed to NASA a plan to launch three 600-lb. real-time repeater communication satellites into a 22,300-mile synchronous orbit.

RCA said that its proposed system could be developed and put into operation by the end of the decade at a total cost of \$400 million. The system would be able to retransmit television programs over a whole subcontinent, such as India; it is believed that this would open up a vast channel for mass communications and education in underdeveloped countries.

Satellites being developed for government and industry for use in the middle of this decade would be capable only of relaying television programs between stations but not directly to home receivers.

Under the RCA plan, the satellite would house a miniature powerplant capable of relaying the television signals with enough power to be received by ordinary home receivers.

The satellite would be powered by a *Snap* device—a compact reactor powerplant being developed by the Atomic Energy Commission—which would generate up to 60 kilowatts of electricity for use in satellites.

During the launching, some of this power would be used to drive an electrical propulsion system that would gradually elevate the satellite to a 22,300-mile-high orbit.

From this orbit, the satellite would be able to transmit television directly to home receivers in an area of 1 million to 3 million square miles.

The Lockheed proposal is designed to provide synchronous communications satellite system which would not be capable of transmitting to home receivers.

Total cost of its proposal is estimated at \$25 million. It calls for the use of an *Atlas-Agena B* launch vehicle with a solid-propellant third stage. ■

missiles and rockets, November 13, 1961



# BIOS First Primarily Biological Shot

Seventeen experiments aboard modified GE craft to probe weightlessness, radiation, g-forces

by Heather M. David

THE FIRST U.S. project to be devoted primarily to biological experiments in space is scheduled to be launched by NASA November 15 from Pt. Arguello, Calif.

*BIOS I*, containing some 17 experiments will be an adapted General Electric *Nerv* capsule. Since the original *Nerv* shot was so successful, only one of six capsules was used. GE modified the remaining capsules for intricately engineered biological experiments at a cost of \$523,000.

Wednesday's shot is to duplicate the *Nerv* shot in every way—altitude, distance and general radiation conditions. Barring a solar storm or a malfunction of the vehicle, radiation data obtained on the *BIOS* shot will be comparable to those of *Nerv*. In addition, the time will coincide with a predicted meteorite stream.

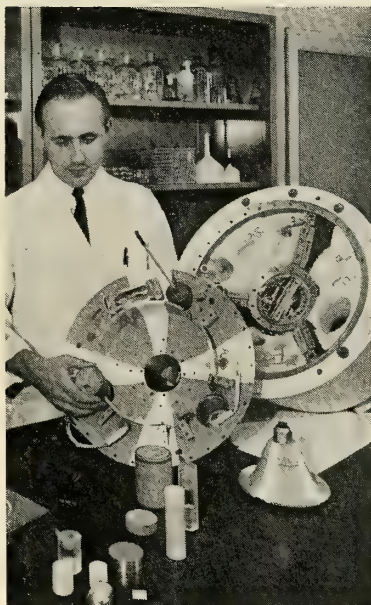
Should the vehicle malfunction, NASA has a backup capsule and booster which would be ready to go within 48 hours.

Like *Nerv*, the capsule will be boosted by an *Argo D-8* to an altitude of 1165 miles—highest know for a U.S. project. The rather steep trajectory carries it a little over 1000 miles down the Pacific Missile Range.

• **Objectives**—The experiments are designed to determine the effects of weightlessness, radiation and high acceleration. They will be exposed to about 25 minutes of weightlessness, accelerations of about 80 g's because of the acute re-entry angle, and Van Allen belt radiation and micrometeorite conditions.

Radiation will be measured by a nuclear emulsion pack mounted on a retractable cylinder. The cylinder will extend after launch, the emulsion pack will revolve one time, and retract before re-entry. The apparatus was designed by Donald A. Kniffen of Goddard.

Devices aboard the capsule will also collect micrometeorite material and record impacts. Otto E. Berg of God-



*BIOS I capsule with 17 experiments weighs 88 lbs., is 17 in. long, 19 in. in diameter.*

dard is responsible for this portion of the probe.

• **Weightlessness experiments**—The *Nerv* capsule was modified to hold some 38 capsules containing material for 17 experiments. Although of a basic nature, each experiment will provide knowledge of how space flight will affect man's basic life processes. The experiments were administered by NASA's Goddard Space Flight Center and Ames Research Center.

One experiment, conducted by General Electric MSVD scientist Dr. Richard W. Price, will indicate whether single cells will "eat" (be nourished) during weightlessness. If research shows that they cannot, it may ultimately lead to allowing man to undergo only short periods of weightlessness, or rotating space vehicles. If, on the other hand, cells do feed normally, any future

loss of weight in astronauts can be attributed to some other cause.

Two small capsules will contain quantities of amoebae, food (paramecium) and a lethal agent, formaldehyde. The amoebae are separated from the food until weightlessness. After weightlessness, they are killed.

Immediately after the vehicle is recovered, the dead specimens will be examined on board the recovery ship by another GE scientist. If the amoebae show food particles, it will prove that weightlessness does not hinder this natural process.

In spite of the extremely high g forces during re-entry—up to 80—Dr. Price said that he does not anticipate a disturbance due to accelerations. Intensive experimentation conducted upon centrifuges shows that cells appear to function normally under this stress. In fact, the GE group has subjected amoebae to as much as 500 g's without change in their habits.

A second GE experiment designed by Dr. Donald R. Ekberg calls for much the same equipment—but the amoebae are recovered alive. By studying the chromosomes in the nuclei, and the ratio of the nuclei to the cytoplasm, Dr. Ekberg will determine whether the external influences brought about any change in the normal growth pattern. The experimenters will also stain the recovered cells to find any alterations in cell chemistry.

The significance of this type of experiment, according to Dr. Price, is that it reduces life processes to the basic level and eliminates any compensatory reaction of the whole organism. Thus, each process can be studied separately.

Florida State University researchers have contributed an experiment to investigate "production of microspheres at zero gravity." This deals with the effect of zero g on fluids, of which human cells are mostly composed.

A sea urchin test will help to show  
(Continued on page 37)

# Chimp Readied for Three-Orbit Flight

**Successful Mercury launch won't necessarily result in manned orbit this year**

by Hal Taylor

SOMETIME in the next few days, NASA will attempt to rocket a medium-sized chimpanzee in a *Mercury* spacecraft into a three-orbit ride around the earth.

NASA officials said that the earliest possible date for the flight of *MA-5* is Nov. 14. Even if the shot goes right on schedule and is executed perfectly, the space agency will still be hard-pressed to achieve a manned orbital flight this year. If there is any delay or technical

problems, the possibility of putting the first American astronaut into orbit this year is out of the question.

*MA-5*, with its chimp passenger, will be boosted into an orbital path of 32 degrees by an *Atlas D* launch vehicle. The orbiting phase of the mission will last approximately 4½ hours at altitudes ranging from about 100 to 150 statute miles.

If the flight proceeds as planned, during the third orbit, as the craft approaches the West Coast of the U.S., the retrorockets will be fired to initiate re-entry.

The spacecraft will begin to enter the atmosphere approximately over Florida and will experience maximum deceleration and re-entry heating at an altitude of about 37 miles. Touchdown and recovery will be about 800 miles southeast of Cape Canaveral.

• **First three-circler**—The flight will mark the first time that the *Mercury* spacecraft has been launched on a three-orbit mission. Its chimp passenger—one of five trained for orbital *Mercury* flights by the Biastronautics Research Laboratory at Alamogordo, N.M.—is being included to prove the adequacy of the spacecraft's various life support systems for a three-orbit mission.

The chimp will ride in a fully operational, specification Environmental Control System (ECS). It will be encased in a pressure-tight metal and plastic box which is connected into the ECS suit circuit in the same manner that an astronaut's suit would be. The animal will be restrained in a form-fitted fibrous plastic pallet by a net harness.

A minor modification has been incorporated into the system to preclude the possibility of excessive oxygen consumption such as occurred during the previous *Mercury* orbital flight.

Postflight investigation of *MA-4* revealed that launch vibrations caused the manual handle controlling the emergency oxygen system to open slightly, thereby allowing higher oxygen flow into the "mechanical astronaut" than was necessary.

Reactions and condition of the chimp during the flight will be monitored and reported by on-board cameras and telemetry.

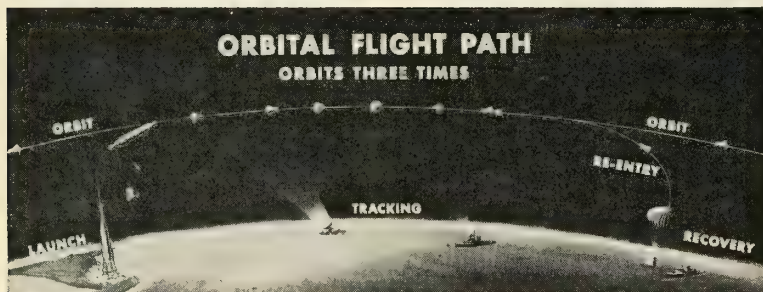
He will be riding in a livable gaseous atmosphere of 100% oxygen maintained at a comfortable room temperature and a pressure equivalent to 27,000-ft. altitude.

• **Treats for Tricks**—A shelf at waist level of the animal has been equipped with three levers and three displays of geometric symbols (simple triangles, squares and circles).

Each psychomotor problem will call for two of the displays being identical—the third odd. The animal will respond correctly by depressing the odd lever under the odd symbol—and when he does will be rewarded with a banana-flavored wafer, slightly larger than an aspirin.

It will be provided through a dispenser on the shelf. Wafers are provided to reward 100 per cent correct responses. Five cc's of water will also be offered.

Each time the animal depresses a



ABOVE: Sketch of the planned trajectory for first three-orbit flight of Mercury capsule.

BELOW: One of NASA's prospective orbiting chimpanzees is fitted in his form-fitted plastic couch with restraining net harness.





lever, the symbols are shuffled. Improper selection of the odd symbol when a problem is presented will result both in the denial of reward and application of a mild electrical shock, administered through the animal's left shoe.

• **Close watch**—Throughout flight, the primate will be photographed by the same camera installed for manned flights; however, it will be shooting through the plastic cover of the pressurized couch. Following flight, an attempt will be made to correlate the appearance of the animal and his state of awareness—i. e. fear, relaxation, drowsiness, sleep or unconsciousness.

Further indication of the animal's condition will be provided by telemetry. Signals emanating from the spacecraft during flight will provide medical monitors at worldwide tracking stations with a running report on the animal's heart rate, blood pressure, respiration and body temperature.

• **Familiar capsule**—The *Mercury* spacecraft used in *MA-5* will be very similar to previous capsules utilized in the *Mercury* program.

It will have a large "picture window" viewing port. Previous *Mercury* spacecraft had two small porthole windows instead of one large window.

It will also have fully operational, specification controls—both the Automatic Stabilization and Control System (ASCS) and the Rate Stabilization and Control System (RSCS).

The latter system provides an alternate means of spacecraft control in the event the ASCS should malfunction. The manual system has not been included, since it is not needed for an unmanned flight.

*MA-5* will provide a further test of a quick release explosive escape hatch which malfunctioned during the second manned *Mercury* suborbital flight.

Four separate camera systems will be carried in *MA-5*. A 16 mm primate observer camera situated on the main instrument panel will photograph the animal throughout the mission until near the time of landing. The camera is to the left of the periscope.

A second 16 mm camera, near the couch, will film the spacecraft instrument panel, providing coverage throughout the mission and for about three minutes after landing. Another 16 mm camera will film the field of view seen through the low magnification of the periscope. The camera will operate for about 2.8 hours following orbit insertion.

A 70 mm earth-sky camera will provide coverage throughout the mission of the view seen through the spacecraft window.

Recovery of the chimp and the spacecraft will be by helicopter. \*\*

## Billions at Stake . . .

# Five Companies Bid For Saturn S-1B Contract

FIVE missile/space industry firms submitted proposals last week on the S-1B first stage for NASA's planned second-generation *Saturn* superbooster.

The competitors are Martin, Aerojet-General, Space Technology Laboratories, General Dynamics/Astronautics and Boeing. NASA said more bids may have been mailed in.

The firms are bidding on a developmental and production contract for the stage which eventually may be worth billions of dollars. Under the current plan, the vehicle will be designed by the Marshall Space Flight Center. NASA is currently preparing launch facilities for the vehicle, which will be capable of 30 launches per year.

NASA has not yet made an official decision as to just how many engines and what total thrust the stage will have. The Golovin Committee has recommended that the stage have four F-1 engines developing 6 million lbs. total thrust. Many top officials at NASA headquarters still support a two-F-1-engine version and are trying to convince Administrator James E. Webb of the correctness of their position. It is almost certain, however that the Golovin Committee view will prevail.

• **Missions**—Current plans for the S-1B stage call for its use to send a three-man *Apollo* spacecraft into orbit around the moon. It will be used for earth orbital flights with the spacecraft.

It is also slated for use as the prime vehicle for manned lunar landings using the orbital rendezvous concept. This would be a two-shot affair, with the second lifting a propulsion module into orbit to be mated with the *Apollo* spacecraft for the moon roundtrip.

The NASA announcement said that the bids will be evaluated and a contract will be awarded in December.

• **S-1 bids weighed**—Meanwhile, the space agency is continuing its study of bids on the S-1 stage of the *Saturn* C-1 booster.

This stage—which was launched successfully on Oct. 27—will have eight H-1 engines with a total stage thrust of 1.5 million lbs. This contract will be awarded late this month and signed sometime in December.

Seven firms—Chrysler, Boeing, Ling-Temco-Vought, Ford Aeronutronic, Avco, Northrop, and Lockheed—are bidding for it.

The C-1 will be used to orbit boilerplate models of the *Apollo* spacecraft

and eventually—when its upper stages are developed—will be able to launch three-man capsules in earth-orbiting trips.

Both launch vehicles will be built at the Michoud, La., plant which NASA recently took over.

Production of both stages will take place simultaneously with work on the C-1, expected to begin early next year. The first C-1's are expected to roll off the assembly lines in late 1963, with C-4 production expected to provide its first complete booster ready for launch in late 1964 or early 1965.

The *Saturn* C-1's will be launched from three pads at Cape Canaveral. One pad, Launch Complex No. 34, was used for the first launch of the vehicle. Launch Complex 39—which will have two pads—will be completed in 1963. About \$20 million has already been expended for the construction of the pad.

Construction of Launch Complex 39—from which the S-1B stages will be launched—will begin early in 1962.

• **Space station study**—In another development, NASA announced the award of a \$95,000 contract to North American Aviation Co. to study the technical feasibility of a large erectable manned space station.

The station would be based on a concept which originated at the NASA Langley Research Center.

Purpose of the study is to identify critical problem areas, establish methods of problem solutions for each of the areas, determine the state-of-the-art advances required in each problem area, and determine the areas where additional or intensified research will be required to delineate a sound research program.

The space station concept has for several years been a subject of basic study by Langley scientists, who conduct theoretical and experimental research on structures, materials, dynamics, and thermal balance.

The aim of this research is to provide a background of technical information necessary for the design of manned orbital laboratories.

The space agency said that any advances in knowledge achieved by Langley's research program are applicable to space stations in general as well as to manned lunar and planetary vehicles. \*\*



# Rendezvous May Cost \$160 Million

by William Beller

NEW COMPUTATIONS by NASA indicate upward of \$160 million may be spent in FY '63 to launch a major R&D program for orbital rendezvous.

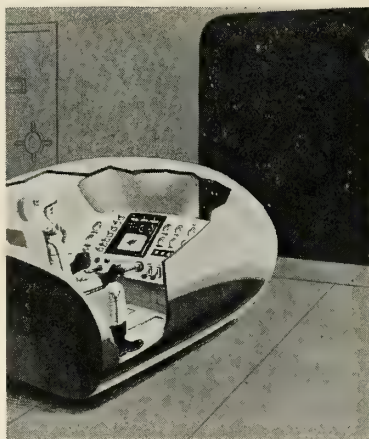
The expected big jump in spending is understood to stem from the soon-to-be-revealed recommendations of the Golovin Committee, which has indicated that rendezvous may be the quickest way for the U.S. to beat Russia to putting a man on the moon (M/R, Oct. 9, p. 16).

The lion's share of the money probably will go into developing a test rendezvous between an unmanned *Mercury Mark I* capsule and an *Agena B* rocket, a key NASA official told MISSILES AND ROCKETS this week.

Another segment of money is earmarked for developing a simulator to train astronauts in rendezvous and docking techniques.

- **The billion-dollar pad**—The concept of a direct flight to the moon via a *Nova* or *Super Nova* is being downgraded. Expense is one of the main reasons.

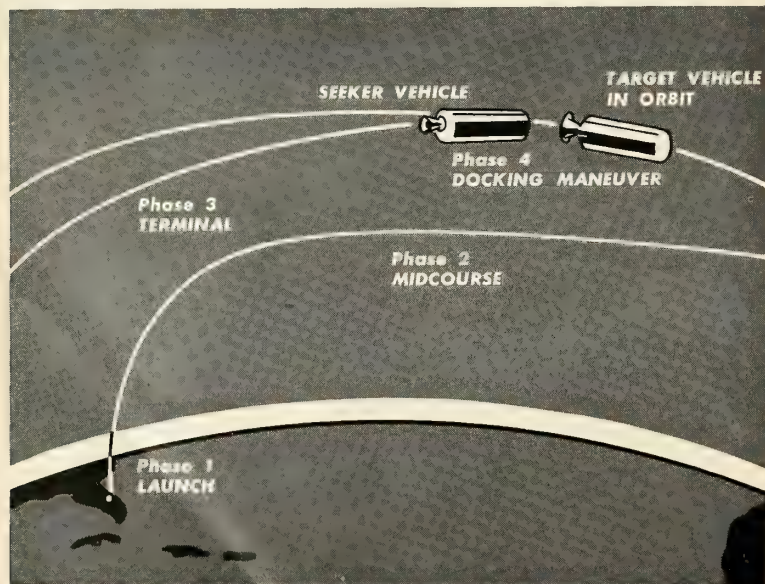
It is estimated that a *Super Nova* pad would need three million pounds of concrete. The LOX facilities needed to fill the *Super Nova* would be bigger than the combination of all the LOX



DRAWING of rendezvous mission simulator.

facilities that are on all the missile bases in the U.S. With all GSE facilities, the *Super Nova* pad would cost about \$1 billion.

NASA committed during Fiscal Year 1961 a little less than \$1 million for orbital rendezvous studies. Administered by the Marshall Space Flight Center, the work was spread among many qualified contractors and universities in order to get a broad spectrum of talent and opinions.



SUCCESSIVE PHASES of orbital rendezvous.

To continue its rendezvous studies during Fiscal Year 1962, the space agency asked Congress for \$2 million, which was upped to \$8 million. Thus, the anticipated oncoming funding for rendezvous is 20 times greater than that Congress recommended for FY 1962. And indications are that it will continue to rise.

The rendezvous or space-station technique has wide potential uses:

- A jump-off point for a lunar mission.

- Military offense and defense.

- Assembly of interplanetary expeditions.

- Refueling operations.

- Repair operations.

- Space crew relief and rotation.

- Crew safety in major launchings.

- Crew rescue.

Here are some of the problem areas that must be looked into before orbital rendezvous can take place:

- **Tracking**—A precise ephemeris of the target satellite must be known. If the satellite is in radio contact with its tracking station, then it's no problem to derive the vehicle's motion to the needed accuracy after a few orbits.

But if the satellite is "non-cooperating" and silent (electronically dark), it must first be found and its path calculated by our "dark fence" detection system and its computers. This might call for considerable enhancement of "dark fence" capabilities, particularly if the target is to be picked up on its first few orbits around the earth.

- **Power control**—To intercept the target and then go through the docking maneuver with its "inching" requirements, the rendezvous vehicle should have throttling control over its engines. The degree of flexibility needed has been compared to the control a driver needs over his car when he's backing into a tight space.

These requirements suggest using restartable, liquid-fueled engines of the throttleable type. Small solid rockets might also be used as an adjunct, because of their simplicity and reliability. For the final docking phase, the exhaust from gas bottles might be used for vector control.

Where sustained operations are called for, the choice would narrow down to some form of electric propulsion.

(Continued on page 42)



# Technical Countdown

## ELECTRONICS

### Guidance Needed for Range Increase

The only way *Asroc* range can be effectively increased beyond its present 8-mile limit is with the addition of a guidance system, a Minneapolis-Honeywell official said recently. *Asroc* is the Navy's surface-to-underwater solid-rocket torpedo (or depth charge). M-H is prime. The idea has been considered by the Navy, but informants say that as of now there are no official plans to effect such a change in the weapon system.

### Radar Anti-jam Potential Grows

New multi-megawatt power amplifier tube developed by Sperry-Rand could greatly enhance radar anti-jamming characteristics in future systems. Called the Meanderline traveling-wave tube, it broadens frequency bandwidths of radars to about 30%—that is, at a frequency of 3 gc, steady amplification could be achieved from 2.55-3.45 gc. This is several times wider than ranges of existing radars. In time, Sperry scientists say megawatt power amplification will be possible over even greater bandwidths, such as from 5-10 gc.

### Tiddle Tests Terminate Successfully

Air Force Systems Command says it has successfully proved its new Time Division Data Link (TDDL) for multiple missile/aircraft defense commands. Nicknamed Tiddle, a single multiplex communications system was used in the Experimental SAGE Sector at Hanscom Field, Mass., to issue multiple commands simultaneously to interceptor aircraft. It will be employed also with *Bomarc-B* surface-to-air guided missiles, the Air Force said. *Bomarc* tests using Tiddle were performed over the Gulf Test Range from Eglin AFB.

### British Plan Massive Show

The biggest international electronics show ever held in Britain will be the London International Engineering Exhibition, organizers say. To be held at Olympia and Earls Court, April 23-May 2, 1963, the 10-day exhibition will require all of the 1 million sq. ft. available in both buildings for an estimated 12,000 exhibitors. With Britain's current negotiations to enter the Common Market, it is no accident that this "biggest of all shows" will overlap the Hanover Fair in West Germany.

## ASTRONAUTICS

### Navy Rocket Gathers Detailed Solar Data

An *Aerobee-High* rocket launched from White Sands Missile Range in August photographed the solar spectrum in about ten times more detail than the best previous experiments, according to scientists of the Naval Research Laboratory. Using an Echelle grating, the experiment resulted in about 5000 spectral lines in the range from 3400 Å to 2150 Å. The Navy says this is the first extreme ultraviolet solar spectrum obtained that compares favorably in resolution with solar spectra in the visible light range.

missiles and rockets, November 13, 1961

### Dyna-Soar Abort Thrust Halved

Thrust requirements have been cut in half for *Dyna-Soar I* separation from booster during early launch period. (There is a short period immediately after launch during which it is possible to separate and recover the hypersonic vehicle.) Abort and recovery techniques have been developed by NASA pilot Neil Armstrong, using an F5D aircraft at Edwards AFB. Flight studies are believed applicable since the F5D, under certain conditions has a lift-to-drag ratio approximating that of *Dyna-Soar* (0.4-0.5).

## SUPPORT EQUIPMENT

### Falcon Monitors Being Built

Under contract from the Air Force, Hughes Aircraft Co. is building four airborne recorders to monitor the operational performance of the armament control system used with the GAR-11, *Falcon*, air-to-air missile. Designated TARP for Tactical Airborne Recording Package, the system consists of an oscillograph recorder and eight plug-in extensions to detect armament control problems as they occur in the air. Armament-system response will be printed on sensitive paper for later evaluation on the ground.

### Helicopter to Carry Pershing Tested

A new medium tactical transport helicopter—capable of airlifting the Army's *Pershing* missile system—was flown for the first time last month, according to Army officials. Nicknamed the Chinook, it is powered by two Lycoming T-55 engines which give it a cruising speed of 150 mph and a range of some 200 miles. The Army expects to accept first deliveries late this year. Payload capacity of the 'copter is estimated at approximately 7 tons.

## ASW & SEABORNE ENGINEERING

### Russians Build Commercial Hydrofoil

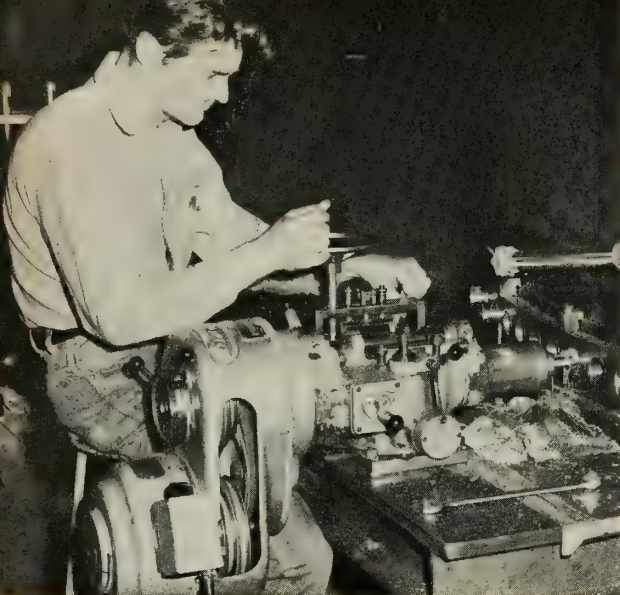
Capitalizing on the commercial potential of hydrofoil ships, the Russians have built an operational hydrofoil craft capable of carrying 150 passengers at speeds up to 40 knots. The ship—called the *Meteor*—is the forerunner of a larger craft, the *Sputnik*, which will be able to carry 300 passengers at speeds of 50 knots. (The *HS Denison* will be this country's first entry into the commercial hydrofoil field. According to its developers, Grumman Aircraft Engineering Corp., this ship will be capable of speeds of 60-80 knots.)

## ADVANCED MATERIALS

### Large Quartz Lens

A huge quartz lens weighing 350 lbs., ground to the tolerances of microscope lenses by Bausch & Lomb, will be part of an optical solar simulation system at Jet Propulsion Laboratory. The system will be housed in a seven-story environmental chamber costing some \$4 million. The 3-ft. lens will focus radiation from source optics into a "virtual source" of radiation within the vacuum portion of the chamber. This virtual source collects and scrambles all the radiation from all the high-intensity Mercury-Xenon lamps and reflects it onto a huge, nitrogen-cooled, parabolic reflector. This unit, in turn, reflects the radiation in parallel beams onto the test plane containing the test vehicle.





*HOLES for the tapered pin joint are drilled with this simple rig.*

SILVER CREEK, N.Y.—A veteran solid motor case fabricator says the U.S. should get moving in the large booster area with available techniques and knowledge—"then refine as you go along."

"If the White House really wants to beat the Russians to the moon," says Leroy Brooks, president of Excelco Developments Inc., "then let's play the game and take the risks. When you're behind and time is running out, you don't play it safe if you want to win."

Brooks feels that the initial stages of the large solid program should follow the *Polaris* approach in the pressure chamber area—use anything that works and forget sophistication. This saves

time, and in the long run, money.

• **R&D motors?**—Excelco is not a production shop, yet more solid cases have been built here than anywhere else in the country. The firm turns out development cases for many ground tests necessary in perfecting solid motors. In spite of this, most of their motors have flown in a number of programs close to, or actually in, operational status.

Brooks is currently fabricating the largest solid chambers to date—120-in. diameter cases for Lockheed Propulsion Co., (formerly Grand Central Rocket Co.) experimental booster. The huge vessels are formed in three sections joined by a Lockheed Propulsion-de-

## propulsion engineering

# Big Booster Cases

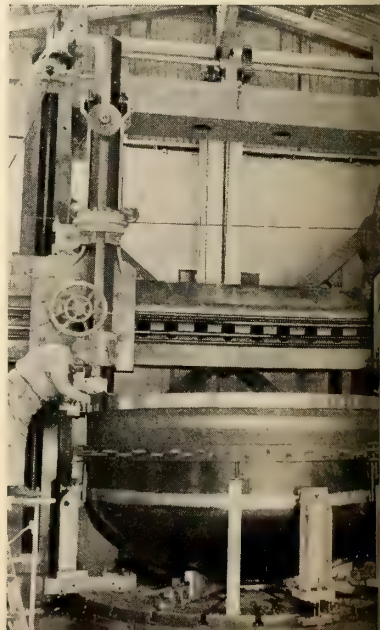
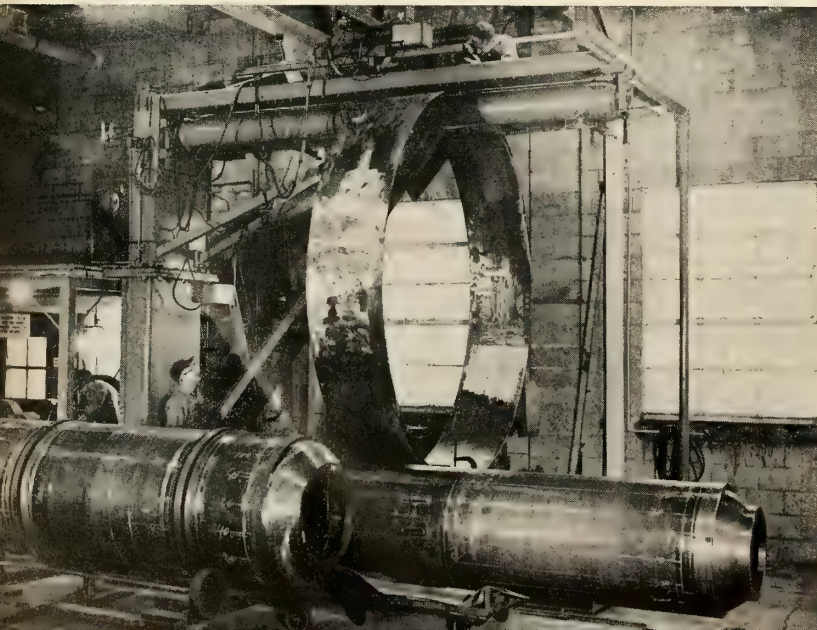
*Excelco's approach is to utilize solid case techniques already available, avoid sophistication; firm makes huge chambers*

by John F. Judge

signed tapered pin arrangement.

Cylindrical sections are rolled and welded into rings, then circumferentially welded to form segments. The equipment at Excelco is geared to handle anything up to 168-in. diameter.

The large booster is a brand new area of case manufacture. Almost all previous experience in the U.S. has been with thin gage material. Some sections of the Lockheed case—rough machined before heat treat—are 3 in. thick. Brooks says this alone is an aspect that demands study and the ideal methods for heat treating operations for such varying thicknesses have yet to be determined. This can be achieved only through experience in working with





# Build Them Now, Refine Them Later

the desired design item.

• **Furnace lead time**—The Lockheed cases are currently heat treated in the large 120-in. furnace at General Electric's Evendale facility—the same unit used in the *Minuteman* motor case program at that firm. If the proposed 160-in. case is specified, then a larger heat treat facility must be built and the best estimate from go-ahead to completion is 9 months. But Brooks says its location cannot be determined until big booster contracts are placed.

The 120-in. case marks the end of the single piece head. The 160-in. cases being proposed will have to use multi-piece end enclosures. The reason is simple—there are no heavy presses in the U.S. large enough and the biggest steel plate rolling mill is limited to around 170-in. square blanks.

Multi-piece heads pose no real problem to Excelco. They have been using them when the occasion demanded it for years.

Excelco's versatility is a product of experience. In the Lockheed program, large boring mills are used as lathes.

Welding is an automatic two-step operation—first an outside weld running about half-way through the workpiece, then a second weld from the inside. The first weld is ground and X-rayed before the second operation commences, and any necessary repairs are made. Another X-ray follows the second welding process. Brooks is quite positive his cases will do the job and hydro-static tests back him up.

"Large cases can be built in about twenty different ways", says Brooks, "and there is too much procrastination." The outspoken fabricator feels that too many people with too many ideas and too many specifications get into the early phases of most programs and the end result is "too much confusion" and "too much delay."

Excelco knows exactly how they would approach the big cases. They would move with whatever is available, similar to the current 120-in. work.

The firm has been in many programs. It actually started out fabricating the liquid fire thrust chamber for the Hermes program and got into the first

large, thin-wall, solid propellant program as a feasibility study along with the Hermes. These cases were known as the RVA 10 (Research Vehicle A-10) and were the first large solid rockets fired from Cape Canaveral.

A partial list of other programs would include the *Sergeant*, Lockheed X-17 *Polaris*, Re-entry X-36, *Jupiter Jr.*, *Jupiter Sr.*, *Polaris O*, *Polaris A*, *Polaris A1X*, *Polaris A-2MOD 1-2-3*, *Nike Hercules*, *Zeus*, *Minuteman*, *Pershing*, *Scout*, and others.

In several of these programs, Excelco has turned out cases in record time without some of the sophisticated frills called for in the specs. The units performed successfully and kept many schedules from slipping. In one instance, Brooks and his methods chopped a year from a crucial program.

There are many problems other than hardware that have to be solved—new fuels, erratic burning, lining, insulators, nozzles, etc. It is not necessary to spend large sums on tooling for high grade designs. All that is needed at this stage of the game is a good pressure vessel. ❖

**FAR LEFT:** Cylindrical sections are welded in a fixture easily expanded to accommodate 160-in.-diam. models.

**LEFT:** Mating sections of the segments are machined to exacting tolerances by modifying standard equipment and imaginative fixturing.

**RIGHT:** The big booster illustrates 1961 state of the art; the long white case represents the largest chamber made in 1958.



# Costs Bolster Case for Solid Booster

**Lockheed's Thackwell asserts that solids, despite weight, can do space jobs far more cheaply than liquids**

THE BATTLE between proponents of liquid and solid propellants for use in space boosters got an unexpected airing last week when a partisan for solids addressed the Third Meeting of the Joint Army-Navy-Air Force-NASA-ARPA Liquid Propellant Group, which convened November 7-9 in Miami.

Following on the heels of the Golo-vin Committee's reported backing of large solid boosters (120 in. dia. and bigger), the speech also furnished some of the reasoning behind the Committee's decisions—based in part on NASA-sponsored studies made at Lockheed Propulsion Co. (formerly Grand Central Rocket Co.), where the speaker is executive vice president.

The Lockheed executive, H. L. Thackwell, Jr., affirmed that solid boosters can perform space missions far cheaper than liquid. Moreover, he recommended that solid rockets be developed as back-ups for the giant-size, liquid upper stages the government is considering using for space missions of international significance.

Chief reason given for using such solid upper-stages is that no liquid hydrogen-oxygen engine of any size has yet been flight tested by the U.S.

• **Solid Saturn booster best**—For Saturn-size launch vehicles using LOX-

Hydrogen propellant upper stages, Thackwell stated:

—The R&D program for a solid booster could be done for less than one-sixth the cost of an equivalent liquid booster using LOX-RP propellant.

—Launching costs would be about the same for each of the vehicles because the solid-boosted vehicle would use the same liquid upper-stages as the comparable liquid-boosted vehicle.

—Manufacture and delivery costs of the solid booster would be less than one-third that of the equivalent LOX-RP liquid booster.

—The overall cost of putting a pound of payload into orbit for 100 routine flights would be cut by more than one-half by using a solid-propellant booster; or, the solid booster would allow twice as much payload to be put into orbit for the same space budget.

For this analysis, Thackwell said his company used actual NASA cost data for liquid-booster development, manufacture, and flight test; and Lockheed Propulsion data for costs of large solid-propellant boosters.

The chief differences between solid and liquid propulsion systems—with respect to cost and performance—are that the hardware part of the solid

booster is cheaper than that of the liquid; but that the liquid booster uses less expensive propellant and also has a higher specific impulse.

As a result, the solid booster must be considerably heavier than a liquid booster having the same mission of accelerating a given upper stage and payload weight to the desired boost velocity.

Noting these facts, Thackwell referred to a recent statement by Werner von Braun, director of NASA's Marshall Space Flight Center: "We must optimize our launch vehicles in terms of minimum overall cost consistent with the time allotted for mission accomplishment, rather than use the meaningless approach of optimizing for minimum gross weight."

In other words, launch vehicles should not be optimized for minimum gross weight but rather for the minimum overall cost to do the required job. Thackwell pointed out that these two criteria are not equivalent to one another:

"For given performance requirements, large solid boosters can be shown to be less costly than large liquid boosters, primarily because the liquid-rocket, non-propellant hardware is . . . so very expensive. . . . The solid boosters will weigh more but they will cost less, both in development and production."

He added that for the much smaller upper stages, which need to be relatively lightweight so as not to "weigh down" the booster stages, the overall cost balance is decidedly in favor of using the much higher specific-impulse LOX-Hydrogen engines, despite their great cost per pound.

• **Liquid hardware costs high**—When a large number of identical space flights are involved—50 or more—the largest cost

**TABLE 1—Liquid- versus solid-booster costs for 8000 fps boost velocity.**

|                      | LOX/HYDROGEN BOOSTER STAGE        | SOLID BOOSTER STAGE                                                      |
|----------------------|-----------------------------------|--------------------------------------------------------------------------|
| PROPELLANT COST/lb   | \$0.20                            | \$1.00                                                                   |
| HARDWARE COST/lb     | \$150.00                          | \$12.00                                                                  |
| PROPELLANT FRACTION  | 0.94                              | 0.88                                                                     |
| HARDWARE FRACTION    | 0.06                              | 0.12                                                                     |
| TOTAL COST/lb        | $0.20(0.94) + 150(0.06) = \$9.19$ | $1.0(0.88) + 12(0.12) = \$2.32$                                          |
| BOOSTER WEIGHT RATIO | 1.0                               | $2.94 (t_b=150)$<br>$2.07 (t_b=75)$                                      |
| BOOSTER COST RATIO   | 1.0                               | $2.32(2.94)/9.47 = 0.72 (t_b=150)$<br>$2.32(2.07)/9.47 = 0.506 (t_b=75)$ |



factor in the launch-vehicle program are the booster manufacturing costs, according to Thackwell. Table 1 shows a simplified comparison of these costs for boosters required for large space-launch vehicles.

Thackwell described the table as showing costs for booster stages made up of clusters of liquid- or solid-rocket engines and include the clustering and interstage structure, and the thrust-vector control systems. Although no costs were included for fueling the liquid booster, the cost of propellant for the solid booster includes propellant loading.

The liquid costs are said to be estimated from NASA data and the solid costs from Lockheed Propulsion Co. data. Both cost estimates are for the tenth delivered booster stage.

Here are Thackwell's conclusions:  
 —LOX-Hydrogen boosters cost four times as much per pound as solid boosters. Therefore, since solid boosters will weigh only two to three times as much as liquid boosters—depending on burning times chosen—the solids will cost only 50% to 70% as much as the liquids.

—In another view, LOX-Hydrogen boosters will cost from 1.4 to twice as much as solid boosters to perform the same high-performance mission. And for boost velocities of less than 8000 fps, the solid boosters will be even more economical. (If a boost velocity of only 5500 fps is required, the LOX-Hydrogen booster will cost nearly 2.7 times as much as the 75-second-burning-time solid booster.)

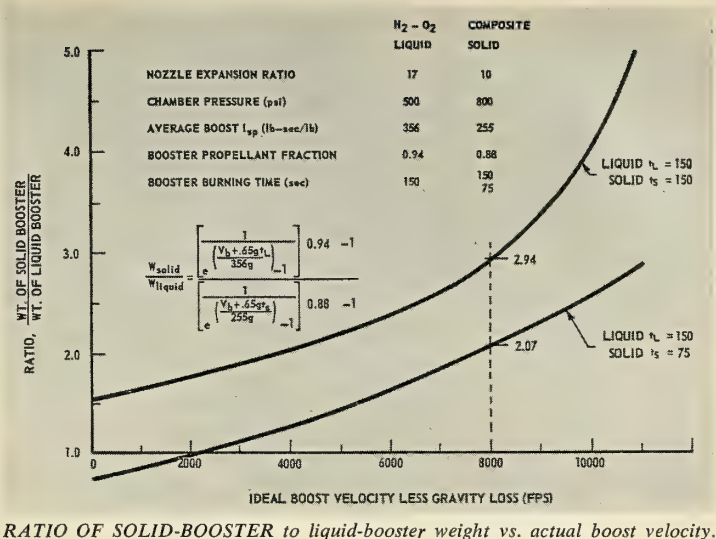
“Forcing the use of liquid propellant systems in the early boost phase represents a ‘round hole, square peg’ combination which could cost the taxpayers billions of dollars over the coming decade,” Thackwell said.

Thackwell admitted that for very large space launchers—such as *Saturn* and *Nova*—the solid vehicle is not clearly the best choice, chiefly because of its lower specific impulse.

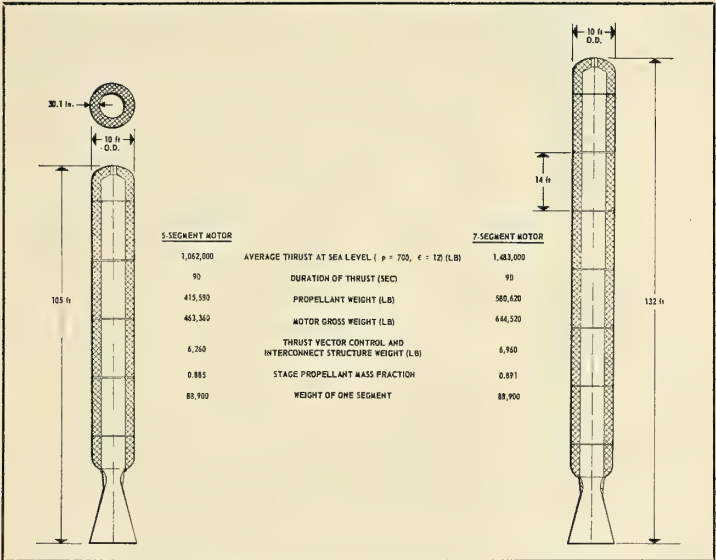
Nevertheless, he warned that “It is entirely possible that excessive delays in the present liquid upper-stage development programs may result because of altitude ignition, sloshing, zero gravity, structure freezing, cluster rigidity or other problems.”

Calling for upper-stage back-ups consolidated with solid boosters, he recommended that a family of simple, all-solid-propellant space launchers be assembled from segmented, solid-propellant-motor building blocks.

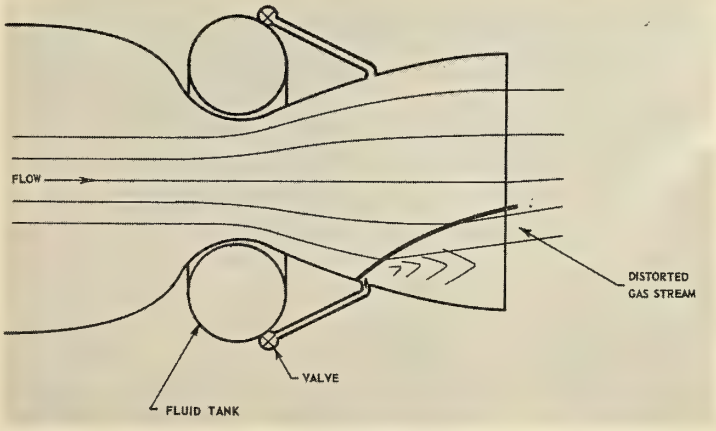
Thackwell maintained that by using 3.5-ft. diameter motor segments, a simple 3-stage, all-solid-propellant launch vehicle able to place 89,000 pounds into orbit could be operational by 1964.



RATIO OF SOLID-BOOSTER to liquid-booster weight vs. actual boost velocity.



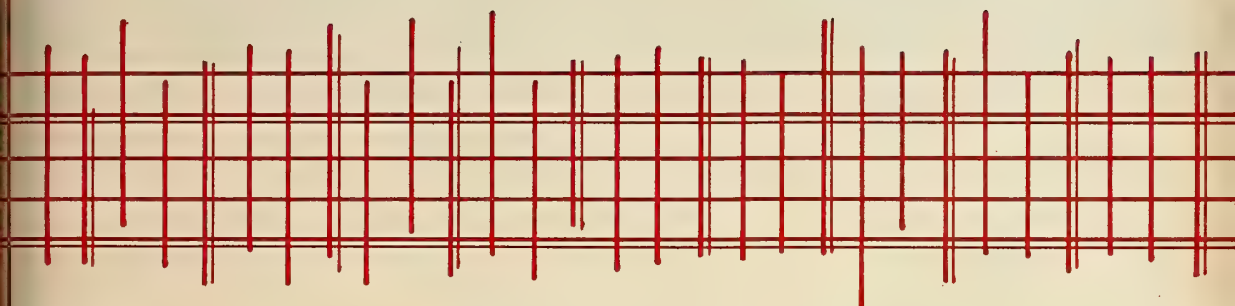
LOCKHEED PROPULSION'S proposed 10-ft.-diameter solid propellant motors.



SECONDARY fluid injection thrust vector control.







# genus: homo • species: sapiens discipline: factors engineering

At the six major RCA Defense Electronic Products facilities, teams of psychologists and design engineers are deeply involved in the highly specialized, incredibly complex study of human factors engineering—man/machine interfaces, auto-instructional methods, decision processes, read-in/read-out optimization techniques, sensory perception, the entire spectrum of psychological-physiological-physical disciplines.

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\*Pyro-Eye measuring temperature in a vacuum furnace. Photo courtesy of Richard D. Brew and Company, Inc., Concord, N. H.

## New Plasma Lab

### Ionospheric Research Gets Air Force Push

THE AIR FORCE will expand its activities in the field of plasma physics research with the construction of a \$636,000 laboratory at L. G. Hanscom Field in Bedford, Mass.

The new Gaseous Physics Research Building will be part of the Air Force Cambridge Research Labs and will house facilities for ionized plasma production, diagnosis, and interaction experiments.

The Farina Corp. of Newton, Mass., has been awarded the construction contract and the building is expected to be completed in October, 1962.

Included in the plant will be equipment for fabrication of gas-filled system and tubes, plasma containers, and experimental devices used in production of ionized plasma. This equipment includes hydrogen-fired and vacuum-type furnaces, electroplating and electrocleaning installations, vacuum evaporators, induction heaters, and standard glass manipulation facilities. Optical and mass spectroscopic facilities will also be available for use in component identification and purity determinations.

• **High power**—The breakdown phase of plasma production may be accomplished by either electrical or physical means. On hand at the research site will be generators capable of peak power outputs, in excess of 10 megawatts at 3000 mc.

Other generators will be available in the UHF range to frequencies of 140,000 mc. These units represent a considerable increase in electrical breakdown power over presently available systems. The power plant for the planned plasma jet lab will be capable of producing high-temperature ionized gas streams generated by 10 kw input power. Solar and arc imaging facilities will be installed for physical breakdown processes.

Facilities will be provided to simulate the required conditions for various diagnostic techniques. These techniques range from plasma probes with weak microwave signals to physical probes involving actual material insertion of particle beams.

The study of actual plasma interactions which will be carried on at the research facility will cover several areas, with considerable effort devoted to ionospheric simulation work. An extreme-environment lab is being installed for this purpose.

High- and low-power microwave labs, and a high-density lab will be equipped to study problems such as communication black-out due to plasma sheaths or nuclear detonations. **tt**

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**PYRO-EYE** delivers a recorder output voltage allowing direct connection with conventional recorders or recorder-controllers.

**PYRO-EYE** accurately measures temperatures over a very wide range. Standard models measure from 750°C to 3500°C (1400°F to 6300°F).

**PYRO-EYE** is ruggedly built; service requirements are minimal. For full information, write for Bulletin 613, describing Pyro-Eye in detail.



**INSTRUMENT DEVELOPMENT LABORATORIES, INC.**

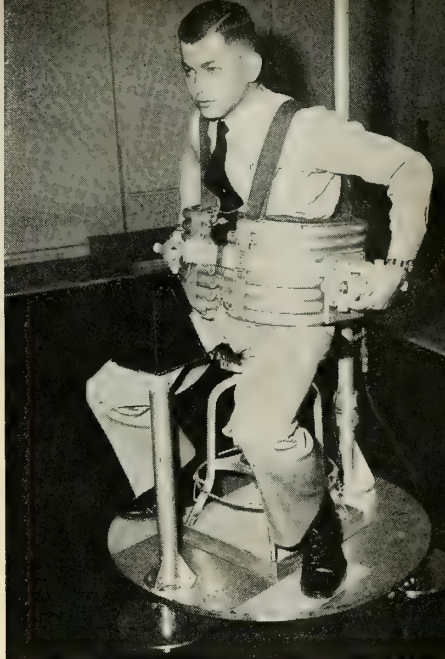
Subsidiary of Kollmorgen Corporation

61 MECHANIC STREET, ATTLEBORO, MASS.





BELL SCIENTIST R. E. Flexman flies through interior of Air Force C-131 during period of weightlessness propelled by experimental model of Zero Gravity Belt.



HORIZONTAL movements with belt are checked out on Bell's air-bearing platform.

## propulsion engineering

# Bell's One-man Belt for Astronauts

A ONE-MAN propulsion system for stabilizing and positioning a free-floating man in an orbital environment is in advanced development by Textron's Bell Aerosystems Co.

A cold-gas engineering prototype unit recently completed 81 flight tests in an Air Force C-131 aircraft flying Keplerian trajectories at high speed to achieve short periods of weightlessness.

Bell scientists say the experimental Zero Gravity Belt has been a successful research tool for evaluating the concept of a self-maneuvering unit and specifying the performance characteristics of improved, operational systems.

The prototype used super-dried high-pressure nitrogen as a propellant because of test environment constraints. The operational model will employ hydrogen peroxide or some other bipropellant more suitable to a space mission.

- **Space corset**—The device consists of high-pressure tube bundles attached to a snugly fitting fiber corset and worn in the middle of the torso. Two thrust controller units are placed on the belt at the body's center of gravity level, one on each side.

Each unit contains a manifold block having eight gas orifices with integral

shutoff valves. The orifices, or thrust valves, are controlled by the operator to propel himself in any direction or axis of rotation. The operator pushes, pulls, lifts, depresses, or rotates the hand controllers in the desired direction. For example, pushing down on the controllers opens the two top thrusters on each manifold block, forcing the man downward.

A total of 32 (1.25 x 0.035 in.) tubes are used. Two tube bundles of 16 each were made in lefts and rights and curved to fit the torso. Two rows of eight each make up a bundle. The tubes in each bundle are manifolded together at the back and hinged for donning ease.

High-pressure flexible tubing connects the manifolds. Nitrogen at 3000 psig is stored in 26 tubes while 6 tubes hold low-pressure gas. The high pressure is reduced through a regulator that keeps the low-pressure tubes at 320 psig.

- **Pressure step-down**—The low-pressure tubes feed directly into the controller manifolds. Chamber pressures of 185 psig provide about 8 lbs. vacuum thrust from each of the two nozzles for fore-aft and lateral translation and 4 lbs. from each of the four nozzles for vertical translation.

The thrust system was designed to produce a maximum of 20 lbs. thrust by using paired thrusters for all translations and rotations.

The controls in the prototype are self-centering and require a 6-lb. actuation force. Control motion is approximately 0.25 in., fully opening or closing the valves.

Maximum thrust at sea-level pressures has been measured at 16.35 lbs. This level can be continuously maintained for only 11 seconds, but short bursts have proven adequate for maneuvering during the short weightlessness periods experienced in the C-131 aircraft.

The belt's ultimate purpose is to permit external, manned inspection, repair and assembly tasks on orbiting space vehicles. The advanced unit will have a simpler control system and might include variable thrust.

The operational propellant may be  $H_2O_2$ —the same system proven successful on Bell's Army Rocket Belt (M/R, June 12, p. 21) and in the reaction control system developed by the firm for the Mercury capsule (M/R, Oct. 9, p. 22). ❖

# Honeywell ESG Slated for Duty

**Company describes first operational electrically suspended gyro as it opens \$5-million missile/space R&D Plant**

by Charles D. LaFond

MINNEAPOLIS—The first electrically suspended gyroscope (ESG) to see military operational use will be used to monitor the Navy's *Polaris* submarine SINS, Ship's Inertial Navigation System.

The result of five years of research by Minneapolis-Honeywell Regulator Co., and a \$15-million investment by the Navy and the Air Force, engineering models will be ready for delivery by next spring. First production models and deliveries to the Navy for installation in its *Polaris* submarine fleet will

begin in mid-1963, a Honeywell spokesman said.

Only one moving part—a superbly machined beryllium rotor—is required by the new gyro. Supported within a vacuum solely by an electromagnetic field within an outer ceramic shell, the hollow sphere is expected to rotate almost indefinitely after initial run-up. Essentially frictionless, it will provide at least magnitude improvement in gyro drift rate compared to the best conventional floated gyro now available.

ESG details and other advanced de-

velopments were revealed here recently by Honeywell officials at a large press gathering prior to dedication and official opening of the company's new Aeronautical Division Research Center. The multimillion-dollar facility will be the heart of Honeywell's advanced R&D effort in inertial systems and flight control technology.

In describing the ESG gyro, R. O. Maze, chief engineer and director of the project, said the baseball-size rotor is fabricated from hot-compacted beryllium. Infinite patience, he stressed, is required in machining and polishing the ball to a final accuracy of better than five millionths of an inch in sphericity.

A diamond scribe is employed later to fashion an intricate pattern on the rotor surface. The pattern permits use of optical pickoffs to sense rotor position when in operation. To minimize the introduction of error by the optical pickoffs, the sensors are accurate to  $\pm 2$  sec. of arc, Maze said.

When the gyro is in operation, separation between rotor and outer shell measures 0.025 in.

In its first application with the SINS, Honeywell's ESG will be used to check and recalibrate each of the three inertial platforms on which the submarine is dependent for navigation. The complete monitor system will include a small special-purpose digital computer to help determine gyro corrective values. Outputs will go directly to the existing NAVDAC control computer used with the SINS, Honeywell said. (All of the other navigational aids used to correct SINS also are routed to the NAVDAC. These include automatic star tracking, Loran-C, and other radio-direction finding inputs.)



**TWO-TON SPACE SIMULATOR** is air-bearing-supported to isolate it from frictional and gravitational influences. Supporting concrete pad beneath is also isolated from building. Developers believe the system is 20 times more accurate than any similar instrument in existence.



# Solaris Subs

*NEW AERONAUTICAL Div. Research Center recently dedicated in Minneapolis represents \$5-million investment by Honeywell. Highlighted in glass front (foreground) is massive analog-digital computer complex capable of simultaneous solution of both scientific and business problems.*



Concurrent with development of the SINS monitor, an advanced ESG also is being built for missile/space application. Considerably smaller than the earlier version, the new gyro will employ a rotor about the size of a golf ball.

The complete gyro will be housed in a cylindrical container measuring 4.75 x 3.5 in. dia. Weighing roughly 4 lbs., the miniaturized package will require less than 4 watts power for operation.

For the future, Honeywell believes the new gyro offers another significant feature: It may be possible, because of the type of suspension, to sense acceleration. If the unit can be instrumented properly to utilize this potential feature, a complete inertial platform could be built using only three gyros and no accelerometers.

• **New research center**—Destined primarily for research and development of advanced missile/space guidance and control systems, Honeywell's new Aero Division facility will provide its 5000 scientific occupants and administrative personnel with every means to reach this end.

An outlay of \$5 million has purchased a plant of 65,000 square feet, equipment, and modernization of other facilities. Besides the typical laboratory facilities expected of such an installation, the new center will have what Honeywell feels are the most advanced clean room facilities and computer complex available in the United States today.

Capable of handling simultaneously both digital and analog computation plus business-type computer problems, the new data processing center has been developed around the M-H 800 computer. This and 16 integrated analog computers will be operated by a staff of

some 117 persons, the company said. Assembled over the past several years, the system cost over \$3 million.

The Company officials indicated that the huge facility will provide computer services to not only the Minneapolis portion of the Aero Division but its St. Petersburg, Fla., and Los Angeles installations.

The clean rooms which will be used for the final assembly of ultra-precision gyroscopes and accelerometers have been refined in design, according to the builders, to a point never before obtained in industry.

Contamination by airborne particles has been reduced significantly. Temperatures and humidity are rigidly controlled, while dust is removed by series-connected mat filter, electrostatic filter and two absolute filters. The complete volume of air in the rooms, Honeywell said, is changed up to 20 times/hr.

Over \$750,000 was spent to perfect the new rooms with the result that airborne contamination of particles over 0.3 micron will be reduced to no more than 5000/cu. ft.

Also, the center includes a superbly balanced spacecraft simulator that will be used to test delicate guidance systems.

Weighing almost 4000 lbs., the simulator has a circular specimen platform measuring 6 ft. in diameter. Its center column is air-bearing-supported. The system is believed 20 times more accurate than any other similar system now in existence.

Heart of the bearing suspension is A 10-in. stainless steel ball machined to an accuracy of  $10^{-5}$  in. in sphericity.

Free to revolve  $360^\circ$ , the instrument has a  $30^\circ$  freedom in the roll and pitch axes.

• **New control for X-15**—Also re-

vealed for the first time by Honeywell officials was the fact that the vaunted M-H adaptive flight control system is being installed in one of NASA's X-15 hypersonic test vehicles.

First flight test using the new system is scheduled for late November or early December, according to C. L. Davis, vice president and general manager of the Aero Division. Prototypes, he said, already have undergone thousands of hours ground testing and over 300 hours of flight testing in an F-94 and an F-101, both supersonic fighter aircraft.

The systems will be used to obtain automatically the best reaction-fuel efficiency and flight control conditions at all operating attitudes and speeds.

Both aerodynamic and reaction jet control are possible with the system, Honeywell said. The same system with but slight modification will be used in the AF Dyna-Soar I boost-glide space vehicle, now being developed by The Boeing Company.

A 92-lb. computer is the central control unit for the system. Employing dual redundancy in its circuitry, the subsystem has a designed reliability estimated at 200,000 hours mean time between failure.

The adaptive flight control system has been in R&D for the past 6 years and in flight test over a period of 12 months, said Honeywell.

The new system is being introduced to the X-15 now to permit the vehicle to attain higher altitudes in its upcoming test flights. Transitions from aerodynamic to reaction controls will take place at about 130,000 ft. For a short period during both atmospheric exit and re-entry both control systems will be energized. **✱**

# Pre-D to Enhance AMR Data Gathering

*Dynatronics system soon to be installed at Canaveral  
increases reliability, reduces complexity and volume of equipment*

ATLANTIC MISSILE RANGE data collection facilities are expected to be greatly improved by an advanced pre-detection/recording system now under development.

The first system, designed and developed by Dynatronics, Inc., of Orlando, Florida, is scheduled for installation at the Air Force Missile Test Center at Cape Canaveral late this year.

Present Air Force plans reportedly include use of additional pre-D systems at down-range stations and on MARS (Mobile Atlantic Range Station) ships.

Also, it is believed that both the Pacific Missile Range and the National Aeronautics and Space Administration are considering use of the system at selected ground stations.

Primary advantage of the pre-D technique, developers say, is that of standardization and minimal equipment outlay for remote stations. One four-rack system will allow such stations to receive and record any type of analog or digital telemetered data, including PCM, FM, PAM, or PDM. It will also handle any data transmissions of the future. This feature, says the Air Force, is especially important in today's transitional period of an increasing use of PCM (digital) telemetry along with extensive use of existing analog equipment and the prospect of combination systems (such as PACM) in the near future.

Basically, the system works like this:

Incoming telemetered signals are picked up in the receiver at the intermediate-frequency stage (before detection) and recorded in the form of an i-f carrier. The modulation sidebands recorded are identical with those of the signal originally received, regardless of the type of modulation used.

Later, this recorded i-f carrier is played back through the detector and demodulator and recorded (and/or displayed) to recover the original video data for processing.

In actual application, the playback

and demodulation processes will be carried out at a central station where different types of detection equipment to fit the specific modulation methods are available. Only one set of the various demodulation systems is thus required to service all the down-range and other remote collection stations.

In addition to this primary advantage, Dynatronics engineers assert there are other advantages in the use of pre-D.

• **Operational advantages**—Operationally, predetection increases the reliability of data acquisition and improves the operational procedures for telemetering systems.

To the user, the value of predetection data collection depends to a great extent upon the number of different types of telemetry signals necessary to record.

For a single missile project—or for a family of vehicles which use the same type of telemetry equipment—building space and operator skill requirements are practically the same whether post-detection or predetection recording is employed. Furthermore, such programs are normally planned and budgeted well in advance for their telemetry requirements so that the necessary facilities are available for operation when required.

By contrast, at the national ranges and other R&D facilities this is not always the case. Many different signal types must be handled each day. Also, frequently, new types of data and foreign signals must be collected upon short notice, with little or no lead time for the procurement of requisite equipment. Budget limitations are always a consideration and the advance training of operating personnel to cope with new types of data modulations is a continuing problem.

Predetection data collection will significantly improve this situation. A single pre-D system in a standard operation can collect any type of data which can be transmitted by a radio within a bandwidth of 2 mc or less and simul-

taneously record several channels of data. Also, it can be shifted quickly to different channels in rapid succession regardless of the type modulation used on each.

Another advantage, developers see, operationally and technically, is the "freedom from frustration" which pre-D brings to the telemetry operator.

Traditionally, operating personnel stand at the equipment during a mission with one eye on the tape machine, one eye on the tuning meter, and one hand on the vernier tuning control. To avoid or minimize distortion they must continually "peak the tuning" to keep the signal centered in the discriminator. As the number of r-f links per bird increases, this procedure becomes more and more difficult.

With pre-D, signals are recorded before the discriminator, and system bandwidths and linearity are ample to tolerate frequency drifts without degradation of the predetected recorded data. Once the data are recorded on tape, repeated playbacks are possible, each tuned up for optimum reproduction of some portion of the transmission.

• **Technical advantages**—The linear operation of predetection recording is greatly superior to the non-linear technique of detection prior to recording, particularly when a desired weak signal is imbedded in strong noise and interference. Any non-linear operation mixes or cross-modulates the signals and noise.

For noise levels comparable to that of the signal, a threshold is rapidly reached, below which a signal is irretrievably lost in the noise. Modest improvements are possible by narrowing the i-f filter bandwidth so that less noise power reaches the detector. However, the filter bandwidth cannot be made smaller than the modulation spectrum bandwidth without reducing the signal power and distorting the detected video. Furthermore, even slight instability of transmitter-receiver frequency would



shift signals outside a narrow i-f passband and seriously degrade data recovery.

Since the predetection recording is linear throughout, it does not marry signals and noise and thus does not suffer when ample i-f bandwidths are employed. I-f selectivity is required primarily to reject interference from strong signals on nearby channels, to avoid overloading the system. Once the signals are on tape they may be played back many times with different combinations of bandwidth, detectors and other adjustments, to get the best possible signal from each section of the mission.

For example, in the boost phase, (while signals are strong), wide-bandwidth playback filters are used. Later, as the signal drops, the tape is stopped and narrowed-band filters switched in. Following a signal dropout, the tape can be played back in reverse so that phase lock, and/or sync, regained during subsequent strong signal reception can be "run back" down the other side of the canyon.

It will also be possible with minor equipment modification to make individual frequency drift corrections during playback, holding the i-f accurately within a narrow passband and precisely centered on the discriminator. Hopefully, other technical advantages of the pre-D technique will be discovered as predetection becomes more common.

• **Theoretical advantages**—A major theoretical advantage of predetection recording is the capability of employing sophisticated correlation detection techniques to recover weak signals that are completely indistinguishable by conventional techniques.

Basically, correlation detection involves the multiplication and averaging of the incoming signal, plus noise, with a locally generated "estimate" of the signal, or of its several possible forms.

In one method, numerous successive trials are made, in each of which the time relationship between the recorded predetection input and local reference signals is successively changed. Correlation—or time synchronism—is indicated by a definite peaking of the integrated product at a certain value of the time shift. Use of this technique in the past permitted radar contact with Venus to be established successfully by M.I.T. from Millstone Hill and contact with the sun from Stanford University.

Another form of correlation detection multiplies the input with each of the several forms in which the unknown signal can be coded. By proper design of the coding function an affirmative "present" output will be obtained from only the detector whose local input code is identical with that of the transmitted

signal.

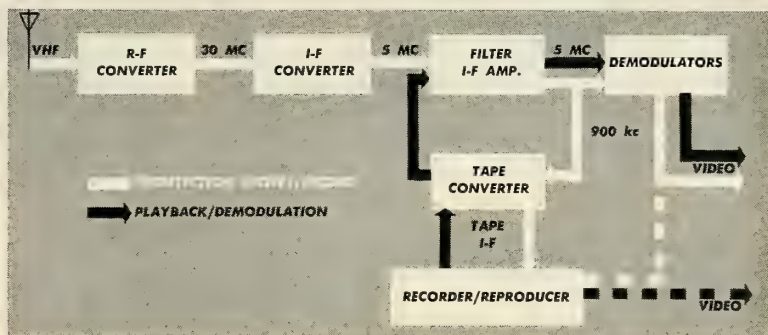
Application of the present AMR predetection data collection system to correlation operations is somewhat limited by the recording medium. In synchronous detection operations, where the timing precision of reproduced signals depends upon physical stability of the tape and mechanical accuracy of the equipment, correlation is practical only over millisecond intervals. More elegant techniques use a precision reference frequency recorded on the tape simultaneously with the signal to minimize physical and mechanical perturbations.

A more fundamental improvement accrues from direct digital processing of the recorded predetected i-f. Elaborate digital sampling and processing techniques were employed in both the Venus and sun radar experiments. Theoretical improvements in signal-to-noise

from 3½ to 120 ips.

A unique feature of the recorder is an automatic dual-machine transfer which permits the collection of data for long periods of time without interruption. As the end of the tape approaches on one machine, a sensor starts a second machine. Data are recorded on both tapes during a 30-sec. overlap period, then the first machine stops and the second continues to record. These novel end-of-tape sensors operate with no marking or other special preparation of the tape to initiate the transfer operation.

In a recent demonstration of the recorder's overall performance, CEC engineers recorded all the r-f signals in the broadcast band (roughly, 1 mc) on a single track of the half-inch tape. On playback, any of the dozens of radio stations broadcasting in the Los Angeles



*RECEIVED VHF SIGNALS are converted to 30 mc, to 5 mc, and then to 900 kc or 450 or 225 kc, according to tape speed i-f for predetection recording. On playback, the reproduced i-f is shifted back up to 5 mc for demodulation. The system can record simultaneously both pre- and post-detected data on the same tape.*

ratio of 40 db or greater are predicted through the employment of correlation detection, made possible through predetection recording.

• **Recorder problems solved**—A major problem in the development of the pre-D system was the requirement for a magnetic tape recorder with characteristics advanced beyond that of available equipment. These needed characteristics included such items as a substantial reduction of intermodulation distortion, frequency response to above 1.5 mc at 120 ips tape speed, and almost complete elimination of dynamic and static tape skew.

The recorder also had to be able to record simultaneously the received signals in both predetected and detected forms.

Such a system was developed for the pre-D system by Consolidated Electrodynamics Corp., according to Dynatronics. It records seven independent data tracks on half-inch magnetic tape at six different tape speeds ranging

area could be tuned in on a receiver connected to the recorder output.

• **"Twinband" technique**—A new method also has been devised by Dynatronics to record certain telemetered signals requiring bandwidth in excess of 1200 kc available in the basic system.

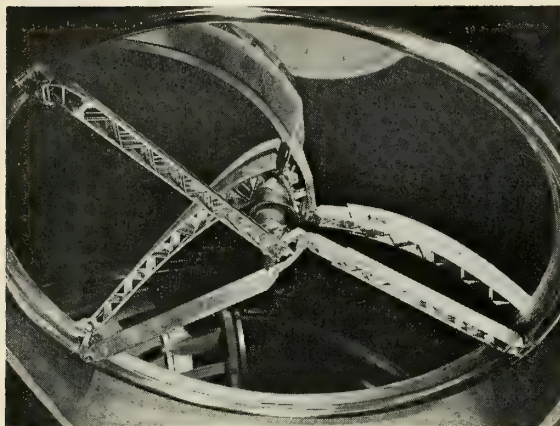
Called "twinband," the technique effectively doubles the bandwidth capability of the system by carefully splitting the wideband input signal, recording the two portions on separate tape tracks, and precisely recombining the signals on playback. Special circuits maintain symmetry and phase-coherence, so that the entire splitting, recording, and splicing operation produces only minor perturbations in the played-back signal.

The company estimates that an effective bandwidth of 2000 kc can be achieved using twinband with detected data distortion of less than 2%. Bandwidths of up to 2400 kc can be handled with the system, developers say, but distortion levels at that spread have not yet been determined.

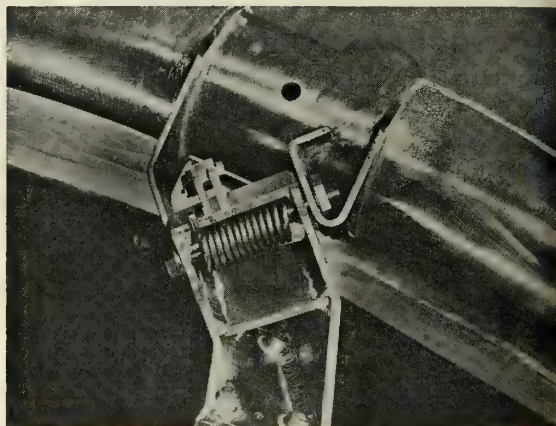
✱



# EOS Perfecting Metal Space Mirrors



**PROTOTYPE MODEL** Solar Energy Conversion System has light, 5-ft. concentrator with generator support struts.



**SUPPORT BRACKET** is integrally electroformed with mirror structure. Arm is thermionic generator support strut.

**LIGHTWEIGHT** metallic mirrors of astronomical quality for space power systems are expected to be achieved within a year at Electro-Optical Systems, Inc.

EOS experts say the factors affecting surface accuracy are well known and understood. Studies in progress are aimed at controlling these variables.

A second objective at the firm is to develop applications and utilization techniques more fully exploiting the unique properties of all-metal mirrors. Besides low weight, metal mirrors have thermal conduction characteristics which can be used to advantage in systems requiring great thermal shock resistance.

Such applications include infrared systems which require cooled optics, and even large earthbound optical systems which suffer from thermal stability problems with glass mirrors.

A long-range possibility is that of actively controlling the mirror figure by precision differential heating.

EOS uses the angular surface deviation in mirror quality comparisons. This is the average or mean angular deviation of surface from the true geometry. The three main ranges are defined in terms of angular error. Thus searchlight-quality mirrors are designated as having an angular error greater than  $\pm 2$  minutes. Sub-astronomical-quality mirrors range between  $\pm 2$  seconds and  $\pm 2$  minutes. Astronomical quality

means an angular error less than 2 seconds.

• **Moving closer**—Searchlight quality is generally adequate for most power system solar generators, but EOS has been able to fabricate mirrors up to 5 ft. in diameter—lying on the borderline between searchlight and sub-astronomical. In smaller diameters—4 to 8 inches—mirrors have reached angular tolerances in the sub-astronomical range (angular errors of 1 minute and smaller).

Determination of the angular deviations of large concentrator reflectors has included a modified Hartmann test, using either the sun or a star as the light source, and photographic evaluation of the image of a bright star or planet such as Venus.

Sub-astronomical values are obtained with standard Ronchi and Foucault tests.

Most of the mirrors formed to date with the EOS process have been parabolas of revolution. Other shapes such as spherical, hyperbolic and elliptical segments, both on- and off-axis, have been made. The aperture ratio, or  $f$  number, has ranged from  $f/8$  to  $f/0.4$ . The process forms all of these with equal ease.

• **Black magic**—EOS forms the mirrors through certain proprietary electro-chemical means. The reflectors are entirely metallic and of one material, with no organic or inorganic bonding elements involved. For maximum

strength-to-weight ratios, a toroidal support or a monocoque backing structure is used. The support is the same material as the reflecting surface, and both are formed in the process.

Mounting or support tabs may also be integrally formed upon the structure as desired during the fabrication process.

The specific weight of these reflectors depends on their size, mounting method and strength requirements. EOS has reflectors with specific weights as low as 0.4 lbs. per square foot.

The 5-ft.-diameter reflector has a value of only 0.8 lbs. per square foot but successfully withstands simulated *Atlas*-launch  $g$  factors. EOS experts say mirrors can be made for nearly any conceivable application with specific weights no greater than 1.5 and probably less than half this value.

Most of the reflectors to date have been overcoated with vacuum-deposited aluminum for maximum reflectivity. Specular reflectance as high as 95% in the visible has been achieved with this coating. Other coatings may be applied with equal ease, with or without protective layers of silicon monoxide. Interference filters are also possible.

EOS can make firm quotations against specifications for these metallic mirrors. They anticipate that for quantities greater than 10, the unit cost would be at least an order of magnitude less than comparable polished glass reflectors.



whether fertilization and cell division are affected by weightlessness. Dr. Richard S. Young of Ames designed this experiment.

• **Radiation experiments** — Several neurospora (mold spores) experiments designed by Dr. A. Gib of Florida State will attempt to detect genetic changes brought about by radiation.

Oak Ridge National Laboratory's Howard I. Adler contributed an experiment using bacteria commonly found in the human intestine to determine its sensitivity to radiation. Another Oak Ridge experimenter, Frederick J. de Serres, has planned tests with dry spores designed to show survival and mutation rate in radiation.

Human blood and white corpuscle cultures will be exposed to radiation and compared with normal blood in an investigation conducted by Michael A. Bender of Oak Ridge. The effect of radiation on nerve fibers will be illustrated by grasshopper neuroblasts in another Oak Ridge experiment.

Barley seed, a genetically stable material, will be studied for radiation effects by Dr. James A. Eugster of the Universities of Bern and Zurich, Switzerland. #

## Lockheed-Georgia Adds Nuclear Lab Facilities

THE LOCKHEED-Georgia Company has expanded its nuclear research plant facilities with the acquisition of the Georgia Nuclear Laboratories, near Dawsonville, through a lease arrangement with the Air Force.

Scientists and engineers at the laboratories' 10,000-acre reservation are currently engaged in studies of radiation effects at low temperatures on various metals. The cryogenic (low-temperature) project, which is being conducted by NASA, has been programed through 1964.

A study is also being carried on by Dr. Robert Platt, of Emory University in Atlanta, concerning radiation effects on plant and animal life in the vicinity of the Dawsonville reactor. Dr. Platt and other leading botanists and biologists from the university are engaged in the long-term ecological study under the terms of an AEC grant.

Current projects within Lockheed-Georgia's nuclear organization include investigations relating to nuclear-powered rocket systems and irradiation shielding for various ground-based and airborne military vehicles. #

missiles and rockets, November 13, 1961

# soviet affairs

By Dr. ALBERT PARRY

## An antimissile missile

was mentioned in Moscow dispatches of October 23 and 24 to New York newspapers as an important boast by Marshal Rodion Ya. Malinovsky in the course of his speech delivered on the evening of October 23 in Moscow, at the 22nd Congress of the USSR's Communist Party. One dispatch by an American correspondent quoted from a Tass summary of the Marshal's speech a statement "that the Soviet Union has solved the problem of antimissile defense." The correspondent continued: "Although the Soviet Defense Minister did not specify whether a weapon had been developed, it was assumed here that he was speaking of an antimissile missile." Another American correspondent cabled that the Tass account included the Marshal's assertion that "the problem of destroying rockets in flight has been successfully solved" by Soviet scientists. Naturally enough, the news made front-page headlines in the American press.

## But did Malinovsky make such claims?

The full Tass text of his October 23 speech, as it appeared in Soviet dailies for October 25, particularly in the authoritative military organ *Krasnaya Zvezda*, has just reached my office. I have examined it closely several times, but do not find any such references outright or implied, to an alleged Soviet antimissile missile, as claimed by Moscow correspondents of the U.S. press. There are indeed a few references to "antirocket defense of the country," but no declarations whatever that its problem has been solved by anything like an antimissile missile.

## Among his remarks on Soviet missiles

the following are of interest: Soviet medium-range rockets (the Marshal revealed), when tried out during this year's field-games of Red rocket troops, hit their targets in 90% of their launchings. At the same time, Russia's ICBM's (according to Malinovsky) showed in their tests a yet better performance. "It may seem strange," the Marshal quipped, "but our rockets hit targets over long distances more precisely than when fired over short distances." At this thinly veiled threat in the American direction, the Communist delegates not only applauded, but also—to quote the Tass report of the session—displayed "a lively merriment."

## Electronic computers were used

in the field during the 1961 maneuvers of the USSR's rocket and other troops, the Marshal said. Missile units proved that they could stop during their marches abruptly and wheel into action at once. The total of rocket units in the Soviet armed forces was placed by the speaker at about "1800 excellent detachments." These units are manned by "great masters of their business who can hit any point of the globe without missing."

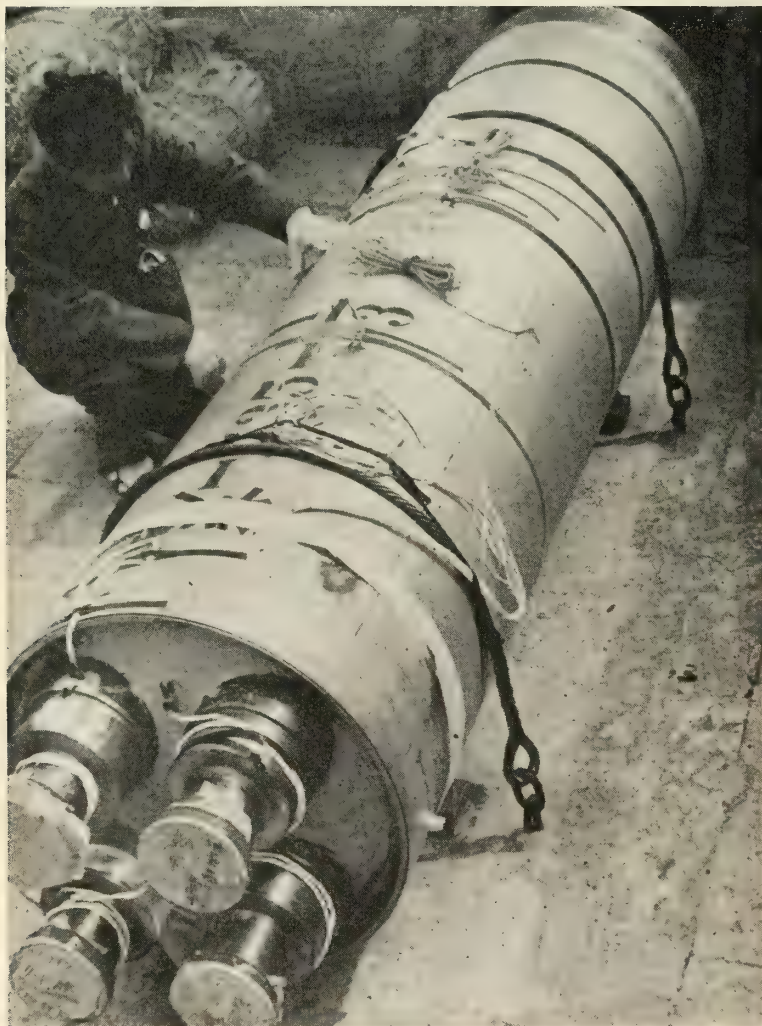
## Rocket weapons are so ample

in the USSR's arsenal (the Marshal went on) that "we are more than sufficiently supplied with missiles of various types and purposes." In the Soviet air force, missiles have replaced guns and machine-guns. "Rocket-bearing planes," Malinovsky announced, "are being introduced more and more widely." These, he added, are able to shoot their rockets from long distances, without going into the enemy's zones of antiaircraft fire. The Soviets' own antiaircraft guns are being rapidly displaced by antiaircraft rockets. The Marshal cited the following figures as illustrating Russia's rocketry advantage in antiaircraft defense: "During the last war, to destroy one enemy plane, antiaircraft guns had to expend an average of 400 to 600 shells. But the modern plane, possessing a great speed and reaching an altitude twice the height that antiaircraft shells can reach, may be shot by one rocket, or, at the most, by two rockets only."

# Japan Testing Large Solid Rocket

**New series of bigger sounding rockets forces move to less confining launch site on Pacific coast, due to be complete next year; solid technology reported advancing rapidly**

by Bernard Poirier



**NEW LAMBDA SERIES** solid booster has Polaris-like nozzle configuration.

JAPANESE sounding rockets have outgrown their existing firing range on the Sea of Japan opposite the Soviet Chinese coastline.

A new test center is being built on the Pacific for the new *Lambda* rockets.

As a follow-on in the Greek letter series, *Lambda* will considerably outperform its best predecessor—*Kappa 9L* which reached a maximum altitude of 236 miles at a launch angle of 82° and later slammed into the Japan Sea at a maximum range of 391 miles when launched at 78°.

Notable in Japan's space effort have been solid propellant progress. Graphical projections show a linear progression in grain diameters from about 9 in. OD in late 1958 to 20 in. OD in early 1961. Recently, *Lambda 1*'s 28-in. OD booster grain was tested on a static stand on Akita Beach.

The booster motor introduced Japan's first four-nozzled configuration instead of a single unit used in all preceding vehicles. *Lambda*'s booster (when full-size) will produce 42 tons thrust for 18 secs. and will use a high tensile strength 100 kg/mm<sup>2</sup> steel plate casing.

The first static test was on an 8 ft motor and a second—about 17 ft. long—will be static-tested during November or December.

Full length—25 ft.—rocket motor static tests are scheduled for completion during fiscal year 1962 and *Lambda 1* should be ready for flight tests at the new Pacific location—Kagoshima Space Station—where completion of construction is expected before the end of 1962.

• **To the beach**—The last vehicle in the *Kappa* series overtook the horizontal usefulness of the Akita Rocket Range. *Kappa 9L*, for example, could have reached the beaches near the Russian city of Olga if fired along the proper azimuth.

Speaking at the Third International Symposium on Rockets and Astronautics, Tokyo, Professor Hideo Itokawa, head of Japan's space efforts, said

missiles and rockets, November 13, 1961



# Expanding Space Program

even by a 80° launching angle, the horizontal range (of *Kappa 9L*) exceeds the geographical dimensions of the Sea of Japan."

For new Japanese sounding rockets, a new launching site was required and a geographic survey was performed along the Pacific Coast of Japan and finally for many reasons," he added, "Kagoshima Space Station was selected and is now under construction."

• **Kappa to Yugoslavs**—The Japanese reportedly have sold \$227,000 worth of *Kappa 6* rockets and GSE to the Yugoslav Astronomical Association. *Kappa 6* is a two stage solid rocket capable of carrying a 22 lb. payload to 47 miles from an 80° launch angle.

Standard instrumentation included accelerometer, decelerometer, skin temperature gauge and strain gauge. Explosive grenades were used to observe temperature and upper atmosphere wind. A geiger counter was installed for cosmic ray counting and a Pirani gauge for pressure measurements. One successful recovery in the Japan Sea was reported for a solar spectrograph package utilizing a float and parachute combination.

Automatic range and direction tracking radar (modified GMDI), four sets of range finders and a DOVAP system installation were used for track-



*KAPPA 8, shown on its carrier, was last of series suitable for old range.*

ing at Akita. Range and direction finders used a frequency of 1680 mc and DOVAP, 40-80 mc.

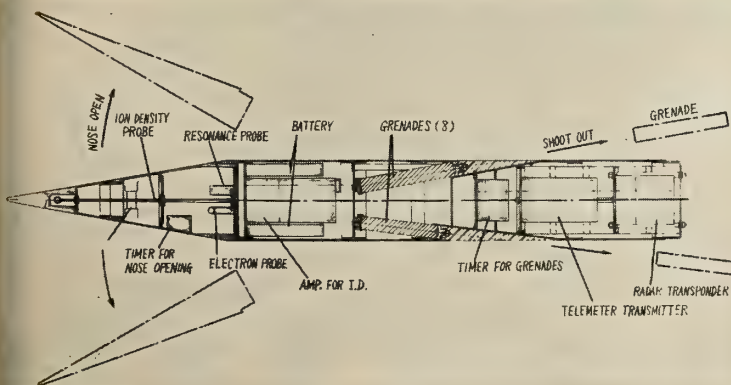
While relatively few construction details are available for the late *Kappa* series, it was revealed that *Booster 420B* for *Kappa 6* had high tensile steel fabrication with tensile strength over 85 kg/mm<sup>2</sup> using a welded butt joint. A 7 mm plate was rolled and welded to the cylindrical shell in this earlier effort.

A concurrent development in the last days of the *Kappa* series was the *Pie* sounding rocket with a glassfibre-reinforced plastic chamber combined with a slow-burning propellant.

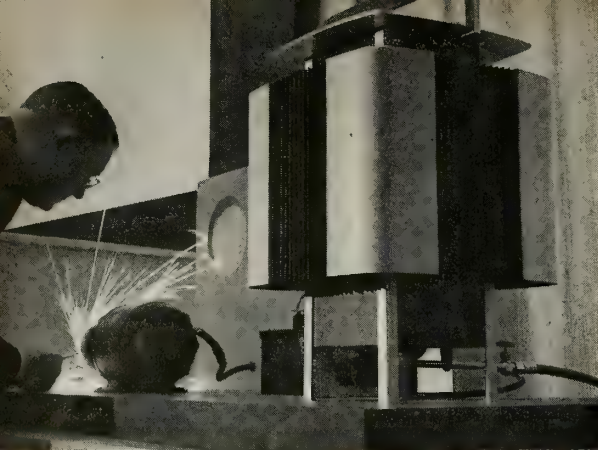
The three-stage *Kappa 9* was Japan's first experience with burning time outside the earth's atmosphere plus the accompanying problem presented by possible aerodynamic heating of the last stage propellant during the flight phases of the two boosters. Other problems involved stage separation and aeroelasticity factors of longer and slender vehicles.

A budget of less than \$1 million was sufficient to bring the University of Japan's sounding rocket program through the *Kappa 6* plus a record of 60 various flight tests by late 1958. Many of these earlier rockets used ceramic coating, aluminum alloys and magnesium coating on the frame, and graphite in the nozzle throat.

The *Lambda* series with multi-nozzled boosters have a mission of placing more than 100 working lbs. over 350 miles into space. Clustered boosters have already been dismissed by Professor Itokawa's rocket team in favor of the new booster design. ■



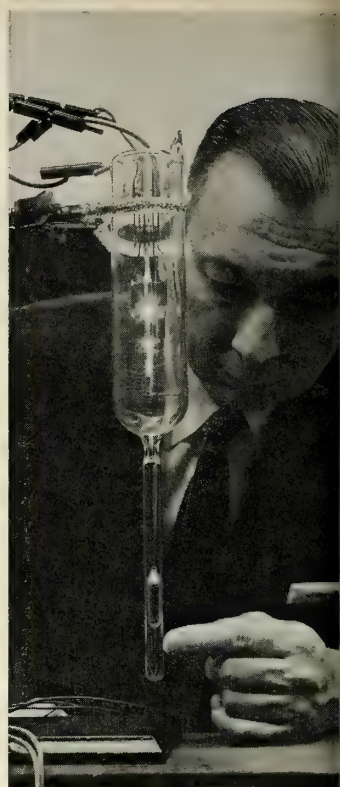
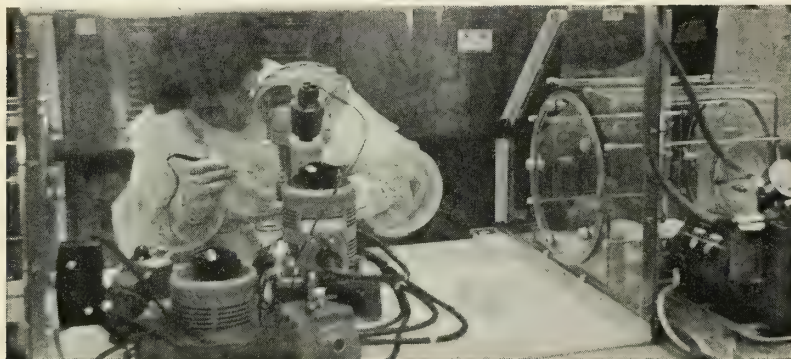
*KAPPA 8 PAYLOAD is designed to take data in deep space.*



**POWER** (left) from a thermo-electric generator under R&D for space work.

**TUBE** (right) provides thermionic generation of power at Westinghouse Research Laboratories.

**SOLDERING** (below) of ferro-electric wafer on hydrovoid production line at Baltimore for Missile System.



## Defense programs draw upon variety of facilities . . .

(Continued from page 13)

Westinghouse's large part of the ship-to-air *Typhon* missile system.

• **Reasons why**—Cresap said he based his forecast of the growth of company sales on the expected near-exhaustion of utility company stockpiles and the acquiring of new contracts on "important defense systems."

Westinghouse's net sales in calendar 1959 totaled \$1,911,000,000. Of this about \$344 million—18%—came from prime contracts and subcontracts for atomic and other defense space products. Net sales in calendar 1960 totaled \$1,956,000,000. Of this, atomic and defense products accounted for about \$391 million—20%.

The corporation's recently issued third-quarter report spoke of still further increases in defense orders despite declines in sales and low prices that affected net sales of other company products. Westinghouse's total net sales for the first nine months of the year totaled \$1,388,000,000—\$65 million under the three-quarter total for last year.

Cresap described the increase in defense orders as "sharp." And he estimated that the expected continuation of the increases will mean a sizeable boost

in the Defense Product Group's percentage of net sales within the next few years.

• **Needs find capabilities**—The basis for his estimates is twofold: Changing requirements and expanding company capabilities in selected areas.

"More and more the role of electronics is accelerating in missile and space and other military systems," he said. "I think it will continue to accelerate."

"In the atomic area, the potentialities are just being scratched. Materials are becoming increasingly important. And the demand for new power sources is insistent."

The square-set executive paused and lit a cigarette.

"In all of these areas, we have large capabilities," he said. "For example, our work in power conversion has an affinity in this whole defense-space field. In the nuclear field, we started some time ago to meet a requirement that we saw coming for nuclear-powered rockets. And because of our commercial and industrial electronics business, we always have had to stay abreast of the whole materials technology."

Moreover, Cresap said, all of these capabilities are being expanded with an eye pointedly fixed on new NASA and

Pentagon space programs.

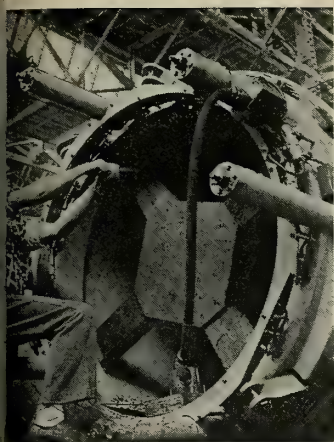
"We keep changing the Westinghouse organization to design our capabilities to the situation," he said. "Only within the last few weeks, we established our new Space Material Department near Pittsburgh. Within the last six months, we established our Astroelectronics Laboratory in California. And our Astronuclear Laboratory at Pittsburgh is already at work on the *Nerva* nuclear-powered rocket engine."

• **Coordination**—These three laboratories are only part of the facilities within the corporation that are being called on by the Defense Product Group to handle various defense contracts. In fact, all of the corporation comes under the Group's purview for possible contributions.

"The job of the Defense Group," Huggins said, "is to bring together, to marshal the capabilities of the entire corporation to perform complete weapon system assignments. *Typhon* is a good example. At least three divisions are participating and before we are through probably a half-dozen will be in the program."

To ensure that no capabilities are missed, Cresap has established within the Defense Group a Defense Advisor



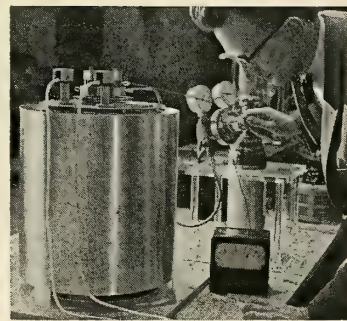
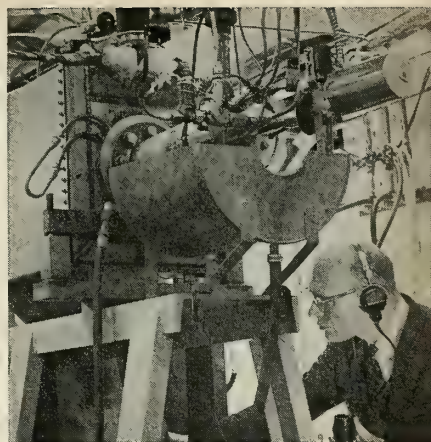


**POLARIS** (above) launching tube at Sunnyvale, Calif., plant.

**ASTOR** (right), at nuclear-tipped torpedo, undergoes final adjustment.

**HOT GAS** (far right top) blasts through magnetic field in first sizeable MHD unit to burn natural fuels.

**FUEL CELL** (far right bottom) in furnace produces electrical energy.



committee to survey the potential defense contributions of all of Westinghouse's more than 100 plants and laboratories. General Boyd is committee chairman. Cresap attends all meetings.

However, although the Defense group has the entire corporation at its call, it has directly under it only the Baltimore Divisions, the Astroelectronics Laboratory and the Space Materials Department. Rather than creating a special defense division as have a number of companies, Westinghouse chose to create an overall staff group with headquarters in Washington.

"We feel that this type of organization can better bring into play all of our capabilities," Huggins explained. These have put us into a good position to take on system primes. We see no need to develop the capability to handle the air frames, which are of relatively declining importance in most cases and can be subcontracted out."

• **Two keys**—Two important factors underpinning Westinghouse's improving position in the missile/space market are continuing emphasis on cost reduction and research.

"Anybody who has a good cost reduction idea that he can prove out will get a go-ahead in this company," Cresap said. "We will find the money for it. This area is essential."

Earlier this year in an address to the Machine Tool Forum in Pittsburgh Cresap put his idea of cost reduction even more bluntly:

"We are determined to replace any piece of equipment, even if it is only one or two years old, if the new machine will give us the required return on the added investment. On the other hand, American industry wants to take the giant step forward. . . . The moderate increase in cutting speed, the 25% improvement in efficiency, just aren't good enough today."

In the field of research, Westinghouse is currently spending about \$200 million a year on in-house and customer-ordered programs. The center of this research is at the sprawling Westinghouse Laboratories in Churchill Borough, about 10 miles from downtown Pittsburgh.

At Churchill Borough, some 1700 scientists, engineers and supporting personnel work in 450 scientific laboratories. Throughout the country, Westinghouse employs some 8000 scientists and engineers on R&E programs.

Great amounts of this research have been concentrated in the fields of nuclear power, materials and the generation of power by direct conversion.

• **Experience in depth**—The leaders of Westinghouse's expanding missile/space role—Cresap, Huggins and Boyd—are respectively a management expert,

a lawyer and a crack test pilot.

Huggins joined Westinghouse in 1943 in the company's Baltimore law department. He served as Assistant Air Force Secretary in the Truman Administration. He is president of NSIA.

Boyd was deputy commander for weapons systems of the old Air Research and Development Command when he retired from the Air Force in 1957 and joined Westinghouse. At the time of his retirement, he had flown more than 300 types of aircraft for a total of some 13,000 hours.

Cresap joined Westinghouse in 1951 as vice president and assistant to the president after his management consulting firm had been employed by the corporation for more than a year. He became the chief executive of Westinghouse in 1959.

Among other things, he brought to the job a sharp insight into management problems, an incisive mind and a broad knowledge of history.

The same year he was named chief corporation executive, he probably summed up best in an address to the NSIA his approach to many of the problems of the defense industry and the world:

"Military technology today," he said, "is a race of science rather than of heavy volume production. The key problem is not how to get more but how to get better."



## Martin-Orlando Reports Savings on Value Analysis

THE MARTIN CO.-Orlando says it has saved \$18 million so far this year on value analysis.

Company spokesmen told a Pentagon Army value analysis seminar that the division had, since its inception five years ago, managed and delivered \$770 million in defense contracts with less than one percent variance from contract price.

The seminar was told that "in the past two and one-half years, we have cut this variance to approximately one-third of one percent while maintaining production schedules."

A five-day value analysis symposium conducted in Orlando produced recommendations by representatives of the military and 14 manufacturing firms involved in the *Pershing* and *Bullpup* programs for potential savings of over \$6 million.

In another development, Martin-Baltimore reported that in the six months ending Sept. 30, 84% of its procurement dollars were spent in labor surplus areas. ■

## Orbital Rendezvous

(Continued from page 18)

• **Guidance**—Inertial guidance would probably be used to put the seeking vehicle into the neighborhood of its target. For the seeker to try to dock on its first orbit is said to be inadvisable because of the strain this maneuver would put on the ground support and guidance systems.

A conservative rendezvous operation would be: (1) after the target is in orbit, launch the seeker; (2) make midcourse corrections so that on its second orbit

the seeker will be close to its target; (3) guide and control the seeker so that it will have the same velocity and attitude as the target; and (4) dock and begin coupling maneuvers.

Since early rendezvous will be between unmanned vehicles, thereby accenting the already difficult "docking" problem, reliance will have to be placed either on ground monitors to bring the vehicles together or on self-contained homing devices. It will be the last 1000 to 2000 feet between the vehicles that will be the most difficult to close.

The last few feet of closure may be handled automatically, perhaps by mag-

netic means. However, there is always danger of a "bump," which might seriously injure the vehicles or disturb their orbits. A less sophisticated but perhaps more effective approach might be to use a television circuit, through which ground observers would issue the commands needed to bring the vehicle together.

• **Coupling**—Once they are near the vehicles must be coupled. Intelligence and perhaps power will have to be transferred between the two vehicles. This calls for an umbilical, either mechanical or electrical.

For manned rendezvous, refueling might be the mission. The propellant would have to be transferred under pressure—assuming they are liquid—because the absence of gravity effect would eliminate the head. Thus, special pumps would have to be designed.

Kurt Stehling of NASA wrote recently that for the refueling operation in space "the slightest leak (in the pipe transferring) cryogenic propellants, if they were used, and at the high pressure ratios existing, would produce a giant cosmic steam-kettle effect."

Moreover, for the manned rendezvous, crew transfers from one vehicle to the other would require either "air locking" together the doors of each vehicle, or permitting passengers to transfer by means of space suits—which have yet to be designed.

## Financial Reports

| COMPANY                          | PERIOD         | INCOME        |               | EARNINGS     |              |
|----------------------------------|----------------|---------------|---------------|--------------|--------------|
|                                  |                | 1961          | 1960          | 1961         | 1960         |
| Air Products & Chemicals, Inc.   | Year, Sept. 30 | \$ 70,427,000 | \$ 61,195,000 | \$ 3,895,000 | \$ 2,495,000 |
| American Bosch Arma Corp.        | 9 Mo. Sept. 30 | 99,560,909    | 93,289,510    | 1,477,763    | 981,976      |
| American Electronics Inc.        | 9 Mo. Sept. 30 | 13,768,002    | 18,947,280    | 209,199      | 381,688      |
| Boeing Co.                       | 9 Mo. Sept. 30 | 1,309,259,940 | 1,202,225,628 | 26,072,956   | 16,167,061   |
| Corning Glass Works              | 9 Mo. Sept. 30 | 170,115,129   | 165,481,036   | 18,481,194   | 17,580,333   |
| Hoffman Electronics Corp.        | 9 Mo. Sept. 30 | 44,462,097    | 38,659,460    | 358,623      | 252,431      |
| Lear, Inc.                       | 9 Mo. Sept. 30 | 70,618,132    | 68,207,920    | 2,169,266    | 1,919,853    |
| North American Aviation, Inc.    | Year, Sept. 30 | 1,265,445,267 | 965,920,852   | 27,750,137   | 23,394,548   |
| Specialty Electronics Dev. Corp. | Year, July 31  | 2,161,838     | 3,908,177     | 65,153       | 174,944      |
| Syston-Donner Corp.              | Year, July 31  | 6,688,000     | 5,396,000     | 600,000      | 477,000      |
| Texas Instruments, Inc.          | 9 Mo. Sept. 30 | 171,937,000   | 170,147,000   | 7,065,000    | 11,517,000   |
| U.S. Industries, Inc.            | 9 Mo. Sept. 30 | 69,093,000    | 68,720,000    | 2,207,000    | -848,000     |

## NASA-contracted orbital operation studies (FY61)

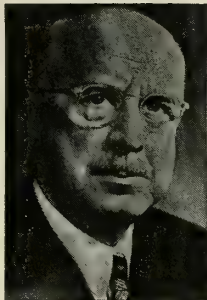
| Subject                                                | Months | Scheduled Completion | Contractor                       | Cost             |
|--------------------------------------------------------|--------|----------------------|----------------------------------|------------------|
| Flight Performance Manual                              | 6      | May 1961             | Martin Northrop Space Tech. Lab. | 0                |
| Orbital Launch Operations                              | 6      | June 1961            | Yought                           | \$ 57,380        |
|                                                        |        |                      | Douglas                          | 92,620           |
| Orbit Launched Vehicles                                | 6      | Sept. 1961           | GD/Astronautics                  | 112,156          |
| Orbital Docking Demonstration                          | 6      | July 1961            | Lockheed (STL)                   | 92,165           |
| Orbital Operations Based on Saturn System Capabilities | 6      | Dec. 1961            | — — —                            | 58,000           |
| Analytical Study of a Satellite Rendezvous             | 12     | Jan. 1962            | North American                   | 100,000          |
| Orbital Transfer & Guidance Studies                    | 12     | Jan. 1962            | Grumman                          | 60,000           |
|                                                        |        |                      | Chrysler                         | 54,601           |
|                                                        |        |                      | Univ. of Alabama                 | 30,000           |
|                                                        |        |                      | Auburn Univ.                     | 26,000           |
|                                                        |        |                      | Univ. of Kentucky                | 24,000           |
|                                                        |        |                      | Univ. of North Carolina          | 32,500           |
| <b>TOTAL</b>                                           |        |                      |                                  | <b>\$871,922</b> |



# names in the news



EVANS



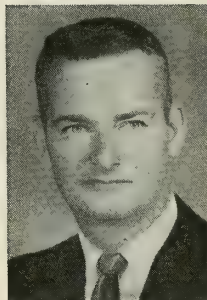
UMSTATT



HANS



MOYER



LEE

**Herbert B. Evans:** Named as vice president in charge of manufacturing and engineering of Harvick Manufacturing Corp., subsidiary of Tenney Engineering, Inc., Evans was formerly with Associated Piping and Engineering Company and with Bethlehem Shipyards Corp.

**Dr. Wilbur A. Hane:** Appointed chief scientist, The Boeing Co.'s AeroSpace Div., Seattle. Replacing him as chief of physics technology is E. N. Sidor. R. L. Shahan named chief of orbital and space systems support section, Physics Technology Dept. Shahan replaces Robert Illman, who joins Boeing's new Military Aircraft Systems Div. M. L. Reeves replaces Shahan as Dyna-Soar contract support chief in orbital and space systems support section.

**Frank M. Sylvester:** Appointed assistant to the president, Hagan Industries, Inc., Corona N.Y., where he will be in charge of ground support equipment programs. Prior to joining Hagan, Sylvester was with Lockheed Aircraft Service, Inc., and Pan American World Airways.

**Walter D. Pitts:** Joins Microwave Development Laboratories, Inc., Natick, Mass., as director of materiel.

**Leo A. Weiss:** Elected to board of directors, Nucleonics, Chemistry & Electronics Shares, Inc. He also is president and chairman of the board of Avien, Inc., which he founded.

**William E. Umstatt,** Chairman of the Executive Committee of the Timken Roller Bearing Company was appointed a Chevalier of the Legion of Honor by a decree signed by the President of the French Republic, Charles de Gaulle. Umstatt has been with Timken Roller Bearing Company since 1919, starting as an inspector, and being named president in 1934. Under his leadership the company tripled in size with new plants established in the United States, Canada, Great Britain, South Africa, Australia, Brazil and France.

**Stanley Goldstein** named project manager, and **Maurice Seisler**, section head,

Ground Support Equipment, both in Systems Div., Avien, Inc.

**James M. Blakely:** Elected vice president of engineering and operations, Sonic Development Corporation of America, New York City. Blakely was assistant to the president, Dayco Corp., until last year when he entered the management consulting business.

**Howard F. Marx:** Formerly director of development planning, Temco Electronics and Missiles Co., appointed director of corporate planning, Ling-Temco-Vought, Inc.

**Edmund Hans:** Western Transistor Corporation of Gardena, Calif., has appointed Hans to the position of Director of Marketing. He was formerly associated with Thompson Ramo Wooldridge Components Co.

**Dr. Guy Suits:** General Electric vice president and director of research, has been chosen to receive the 1962 Industrial Research Institute Medal. Representing 175 U.S. companies, the Institute cites Dr. Suits' "skill and leadership in promoting the growth of an industrial research laboratory enjoying worldwide recognition . . . for successfully interpreting research results to company management and the general public and for varied technological advisory services to the government of his country."

**Robert Peth:** Promoted to manager, Engineering, Mobile and Portable Communications Products, Motorola's Communications Div. **John F. Mitchell** replaces him as chief engineer. **C. Harry Knowles** named assistant general manager, Research and Advanced Development, for Motorola's Semiconductor Products Div. in Phoenix, Ariz.

**Dr. James W. Moyer:** Has joined Servomechanisms/Inc. as director of research, Research and Development Center, Santa Barbara. Dr. Moyer previously served as director of research at the Sperry Rand Research Center, Sudbury, Mass. Prior to that, he was associated with the General

Electric Company, with the Rochester Ordnance District and worked on the Manhattan Project at Berkeley and Oak Ridge.

**Robert B. Swope** and **Robert P. McMillan:** Chairman and president, respectively, Southern Oxygen Co., elected to board of directors, Air Products & Chemicals, Inc., Allentown, Pa. Southern Oxygen was recently acquired by Air Products through an exchange of stock.

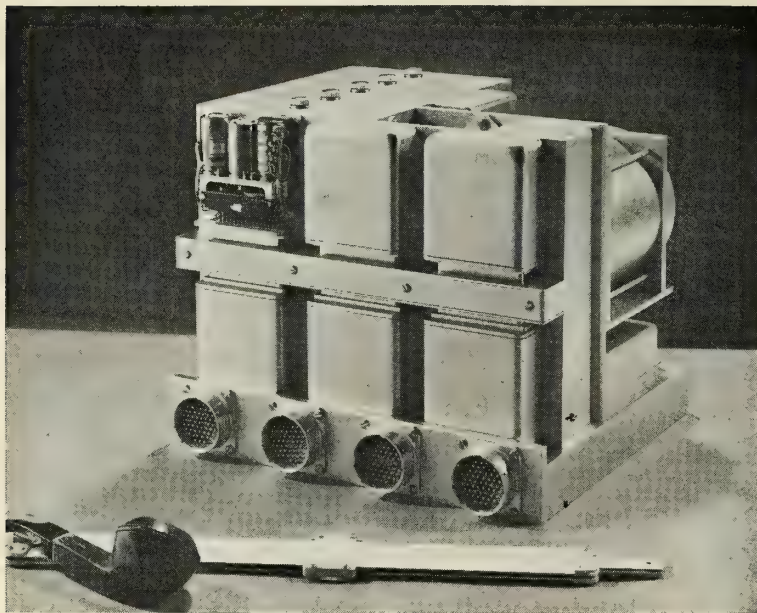
**A. M. Andrews, Jr.:** Appointed president of Aircro Company International, a division of Air Reduction Company, Inc. Andrews has been with the company since 1944.

**Gerhard Neumann:** Appointed general manager, General Electric's Flight Propulsion Div., succeeding Neil E. Firestone, who is on special assignment with the company's Project Apollo team. **David F. Shaw** becomes general manager, Large Jet Engine Dept., Evendale, Ohio; **Edward Woll**, general manager, Small Aircraft Engine Dept., West Lynn, Mass., succeeding Neumann.

**Robert H. Lee:** Appointed to the new position of director of engineering for Kurz and Root Company, Appleton, Wis., and its subsidiaries. He will have direct supervision of engineering at all four division and subsidiary locations. Prior to his present position, Lee was director of engineering for Basler Electric Company and its affiliate, Power Supplies, Inc., of Illinois, and held the post of chief engineer of Rectifier Division, P. F. Mallory Company, Indianapolis, Ind.

**Dr. Leo L. Beranek:** Received the Wallace Clement Sabine Award of the Acoustical Society of America for his internationally recognized achievements in all phases of architectural acoustics. He is the president of Bolt Beranek and Newman, Inc. of Cambridge, Mass. Also, **Dr. Albert B. Wood** of the Admiralty Research Laboratory in Teddington, Middlesex, England, received the Pioneers of Underwater Sound Award. Both recipients received the awards at the 62nd Meeting of Acoustical Society of America.





## New Product of the Week: Miniature Digital Computer

The L-70, one of the world's smallest digital computers, is available from General Precision's Librascope Division.

The computer weighs only 19 lb. and employs a new design approach to the memory-drum concept. The L-70's memory drum, utilizes a thin film of helium as a bearing for the rotating drum. The entire memory system weighs slightly over 5 lb.

The drum spins on a thin film of gas instead of a metal bearing as in earlier systems. The design approach eliminates the mechanical wear of a metal suspension system and allows closer tolerances between the drum and the magnetic devices that record and withdraw data. This latter feature allows for greater memory capacity. The gas-bearing drum has been successfully tested at vibration and shock levels greater than current space-vehicle requirements.

Circle No. 225 on Subscriber Service Card

## Electronic Chassis

Vent-Rak, Inc. is marketing an electronic chassis developed to permit high flexibility in electronic mounting. Eliminating the old "bread-board" concept of assembly, Vent-Rak offers boards in

4¼-in. increments that permit a wide variety of arrangements to suit individual requirements. The sub plates, which make up into a standard chassis 17 in. wide and up to 21¼ in. deep or larger, permit several engineers to work on the same project simultaneously, and allow each plate to be detached and replaced without modification.

Circle No. 226 on Subscriber Service Card

## High-mu Triode

United Electronics Co., subsidiary of Ling-Temco-Vought, Inc., is marketing Tube No. 581, a miniature high vacuum high-mu triode designed for pulse modulator service. In this service it can deliver 13 kilowatts pulse power output. Maximum anode voltage is 20 kilovolts, peak plate current is 1.2 amperes, and grid bias is 300 volts.

Circle No. 227 on Subscriber Service Card

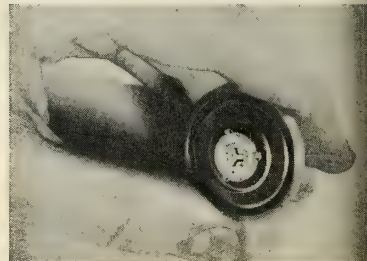
## Servo-Motor Package

A compact servo-motor package featuring a highly integrated design is available from the Aero Hydraulic Division of Vickers Inc. Developed for missile and aircraft control systems, the package incorporates the hydraulic motor, servo valve and internal relief valves in one housing. Advantages include approximately 20% reduction in weight, 30% reduction in size, a minimum volume of oil under compression and an internal case drain. Use of a high-case-pressure motor reduces break-away torque to only ¼ that of a comparable manifolded standard motor and servo valve.

Circle No. 228 on Subscriber Service Card

## Ag/Cd Button Cells

Pilot production of the first hermetically-sealed, rechargeable silver-cadmium "button cells" has been started by Yardney Electric Corp. Because each cell is only a little larger in diameter

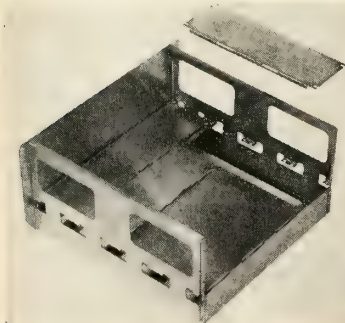


than a half-dollar, batteries of miniature size can be assembled that offer unlimited possibilities in electronic and electrical applications. This type of maintenance-free button cell will have up to 75% more capacity than ordinary rechargeable button cells of the same size, and a cycle life almost 60% greater. The company plans to make modules available of 0.25-, 0.50-, 1-, 2-, 4-, and 6 ampere-hour (D-size) capacity.

Circle No. 229 on Subscriber Service Card

## Soldering Panel

A panel designed to consolidate several operations into one simple, fast and positive method of location in assembling or soldering groups of wires into various types of plugs, is available from Winslow Product Engineering Corp. Operation of panel is extremely simple; no operator training is necessary. To wire a given plug, the operator selects a plug adaptor and chart which matches the plug. Charts can be furnished to correspond with plug in either letter or number configuration. Adaptor and chart are inserted into





position on the panel. The operator then connects the plug to be wired to the plug adaptor and begins to wire. When the soldering iron or probe touches a plug pin the corresponding number, or letter, lights up on the chart. This indicates that the proper pin is being wired.

Circle No. 230 on Subscriber Service Card

## Commutator

Datametrics Incorporated has a telemetry commutator featuring low contact noise and long life. Sampling rates as high as 1350 per second are offered with a standard 90-channel unit. Life is 1000 hours minimum at the highest sampling rate and increases as the sampling rate is reduced. Standard channel capacities are 30, 60, and 90, and up to 10 poles can be accommodated. Standard sampling speeds are 1, 2, 5, 10 and 15 revolutions per second. Contact noise is less than 5 volts, which permits strain gauge or thermocouple outputs to be fed directly into the Datacel without preamplification.

Circle No. 231 on Subscriber Service Card

## Epitaxial Transistors

General Electric Co. is marketing a new series of planar, epitaxial, passivated silicon transistors designed for use in industrial and military high-speed switching and high-frequency amplifier circuits. The transistors operate at frequencies from 50 megacycles to above 120 megacycles. The six transistors which comprise the P.E.P. series have been designated types 2N2193 through 2N2195 and 2N2193A through 2N2195A. In addition, the firm has available seven silicon planar transistors. These components are types 2N696 through 2N699, 2N1613, 2N1711 and 2N1893.

Circle No. 232 on Subscriber Service Card

## Magnetic Core Memories

A series of magnetic core memories or use in the design of data conversion and data processing systems is available from the Electronic Engineering Co. The EECO 8-level series has a capacity of 128 to 2048 characters and is available in three different models; random



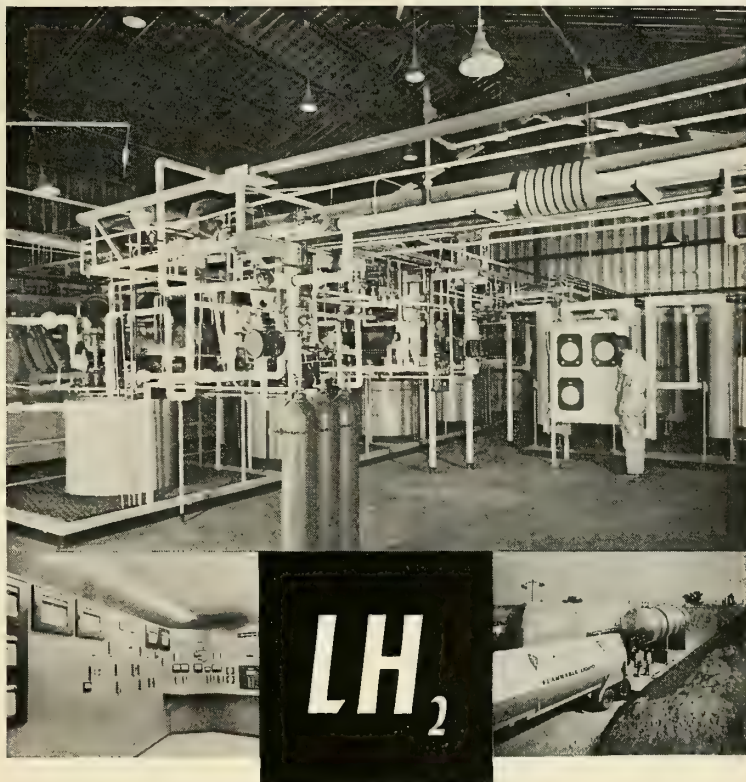
missiles and rockets, November 13, 1961

access, sequential access, and sequential interlace. Because of the variation of character capacity and the access, a total of 15 models of the new 8-level series are available. Speed of the new series is 200 kc or 5 microseconds between load and unload commands. Readout is non-destructive and data remains in the memory until new data is loaded or the ERASE signal is received. An ERASE signal will clear the entire memory. Separate front panel indicators display each bit in input register, output register, load address, and unload address.

Circle No. 233 on Subscriber Service Card

## Silicon Power Supplies

S-series 24-volt and 50-volt power equipment developed by Raytheon Co. features non-aging silicon power rectifiers to help reduce cabinet size by as much as 50%. Designed for wide communications applications, the power supplies include battery chargers, battery eliminators, and end-cell chargers. Simplified and standardized ferro-resonant design is employed to eliminate extraneous semiconductor control circuitry and increase unit reliability and operational life. All S-Series power supplies provide stable and filtered d-c regulated to within  $\pm 1$  percent of the



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## ...products and processes

rated value with loads from 0-100% and AC line variations from 95-130. Complete overload and short circuit protection is built into the design.

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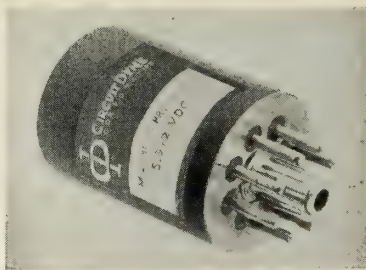
### Slotted Lines

Antenna Systems, Inc., is marketing a complete line of slotted lines in all waveguide sizes from WR-430 through WR-2300. The residual VSWR is 1 less than 1.02 and the slope is less than 0.1 db. The standard units are supplied with a broad bank probe, but tunable or RF probes are available on request. The line can be calibrated in either inches or centimeters.

Circle No. 235 on Subscriber Service Card

### Voltage Reference

Isolation from line voltage changes in the order of 100 db is one of the primary features of a voltage reference supply available from CircuitDyne Corp. A solid-state device, designated Type PR1, the VR source is available in models to accept both 115 volt and 6.3 volt inputs, from 50 to 400 cps. Outputs may be specified at 5.9, 8.6, 11.0, 14.5, 17.2 and 22.0 volts, nominally. Actual



output voltages are calibrated for each individual unit and stamped on the case.

Circle No. 236 on Subscriber Service Card

### Multiplier Phototube

A 2 in.-diameter head-on type of multiplier phototube is available from the RCA Electron Tube Division. The RCA-8053 is the third of a trio of recently developed RCA phototubes utilizing a venetian-blind dynode structure and having S-11 response.

Design features of the tube include a semi-transparent photocathode having a minimum useful diameter of 1.68 in.; a first dynode having large area; a flat window to facilitate the mounting of flat phosphor crystals; and 10 dynode (sec-

ondary emitter) stages. The RCA-8053 has a median radiant sensitivity of  $1.5 \times 10^4$  amperes per watt at 4400 angstroms (approximately 20 amperes per lumen) when operated at a supply voltage of 1500 volts.

Circle No. 237 on Subscriber Service Card

### Thermoelectric Coolers

A line of 2- and 3-stage cascade thermoelectric coolers that will reach  $-95^\circ\text{C}$  from a sink temperature of  $+20^\circ\text{C}$  with an input of only 3.0 amps max. is available from Jepson Thermoelectrics. Varying the current varies temperature. These 2- and 3-stage cascade coolers eliminate the comparatively immense weight and bulk of  $\text{CO}_2$  cooling systems and storage tanks usually required to cool infrared and photoelectric cells and parametric amplifiers in missile and commercial applications.

Circle No. 238 on Subscriber Service Card

### Digital Recorder

A new digital recorder featuring high-speed, flexible data input with information storage is now available from Hewlett-Packard Company. The transistorized, electro-mechanical recorder can print up to five 11 digit lines per second. A storage feature allows data transfer in 2 milliseconds, after which the driving source is released to gather more information. Internal connectors route parallel-entry data to any described digit, and different input codes may be used for each digit.

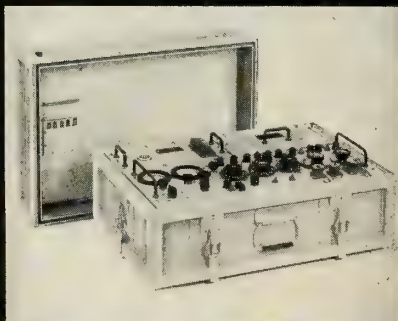
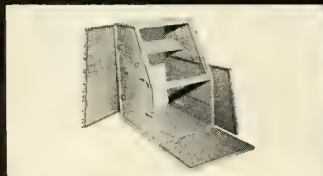
Circle No. 239 on Subscriber Service Card

### Sampling Oscilloscope

A sampling oscilloscope which gives calibrated, high-resolution measurement of nanosecond pulse phenomena is available from Hewlett-Packard Company. Model 185B features conventional controls, direct reading and bright-trace observation, and a standard 5-in. mono-accelerator CRT. When

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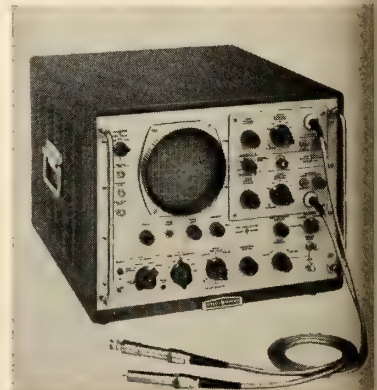


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Circle No. 7 on Subscriber Service Card



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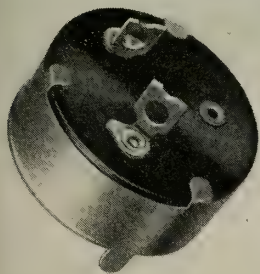


equipped with a Model 187B Plug-In Dual Trace Amplifier, the Model 185B o 1000 mc, can be synchronized up to o 1000 mc, acn be synchronized up to 000 mc, and permits full-screen presentation of signals from 0.3 nanosec-ond to 100 microseconds.

Circle No. 240 on Subscriber Service Card

## Push-Pull Switch

A push-pull switch design resulting in savings up to 60% assembly time. Costs of wiring operations is available from Clarostat Mfg. Co., Inc. The Series AG Push-Pull Switch for control/switch combinations completely eliminates the need for solder shields and



results in greater dependability through better access to terminals during soldering operations. The Series AG employs design technique whereby the usual terminal holding the terminal board is eliminated.

Circle No. 241 on Subscriber Service Card

## Wave Tube

A miniature traveling wave tube that will provide high power and broad bandwidth for space communication systems is in production at the Sperry Electronic Tube Division. Called the TX-186, the amplifier produces more than 10 watts over frequency ranges from 5000 to 11,000 mc. The 9-in. long, 1-lb. traveling wave tube is capable of realizing a 40-db gain. Beam voltage is held to 2200 volts.

Circle No. 242 on Subscriber Service Card

## Carbon Film Resistors

A line of precision carbon film resistors is available from Pyrofilm Resistor Co. The PT-D Series incorporates old flash protected Dumet leads making them ideal for welded packaging techniques. These weldable leads provide exceptional strength and resistance to twisting, at least 25 lbs. and 10°-60° twists.

Circle No. 243 on Subscriber Service Card

missiles and rockets, November 13, 1961

## new literature

**MICROWAVE**—A catalog listing over 200 standard microwave components and solid-state devices is available at E & M Laboratories. Included in the catalog are the several hundred new items developed during the past year as well as an updating of the specifications which appeared in last year's catalog. Described are waveguide isolators, coaxial isolators, duplexers, switches, electronic attenuators, modulators, phase shifter, and circulators, as well as the pertinent electrical and physical characteristics of each unit.

Circle No. 200 on Subscriber Service Card

**GEARS/CLUTCHES**—SIAMCO, Division of Tech-Ohm Electronics, has available its new 140-page catalog #100. This catalog features such items as precision gears, magnetic clutches and brakes, differentials, couplings, gear heads, limit stops, bearings, electronic hardware and other items which have application in the electro-mechanical field.

Circle No. 201 on Subscriber Service Card

**SIGNAL CONDITIONER**—Astra Tech's Bulletin 201 describes the first model (TSC-1) of the company's thermocouple signal-conditioning line. The TSC-1, depicted brochure, is available as a single-channel system and expandable to eight channels through plug-in cards. Design is compact, smaller than other commercially available thermocouple signal conditioners. The unit has five front-panel operating controls. Complete physical and electrical specifications are provided, as well as a photograph of the TSC-1. Available accessories are listed and described.

Circle No. 202 on Subscriber Service Card

**RECORDERS**—Null Balance Recorders and Recording Controllers—(GEA-6887A.) 12 pages, describes General Electric's complete line of single and multi-pen null balance recorders and recorder-controllers. Also discussed are multi-point recorders and multi-purpose indicators. Descriptions of typical measurements performed by the recorders and controllers are outlined in a special section. The illustrated bulletin contains information on features, dimensions, specifications, optional accessories and applications.

Circle No. 203 on Subscriber Service Card



## MICRO PRECISION HOLES

FROM .0001" DIA.

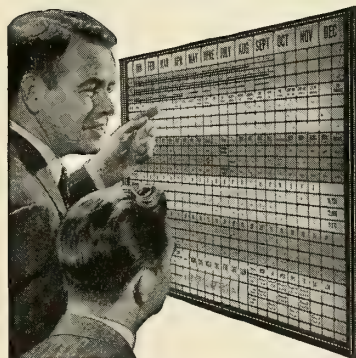
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## contracts

### AIR FORCE

- \$17,040,000—The Martin Co., Denver, for continued development and fabrication of *Titan* missiles.
- \$10,925,000—The Martin Co., Denver for research, development and testing of *Titan II* missiles.
- \$8,736,500—Hughes Aircraft Co., Culver City, Calif., for production of *Falcon* missiles and related items (2 contracts).
- \$4,320,000—Hercules Powder Co., for production of third-stage engines for *Minuteman*; work to be done at Bacchus, Utah.
- \$1,328,978—Lockheed Aircraft Corp., Sunnyvale, Calif., for work on classified project.
- \$1,120,000—Boeing Co., Seattle, for support of *Minuteman* work at Whiteman AFB, Mo.
- \$636,150—Farina Corp., Newton, Mass., for construction of a gaseous physics research building at Laurence G. Hanscom Field, Bedford, Mass., for operational use of the AF Cambridge Research Laboratories' Electronics Research Directorate.
- \$200,000—Thiokol Chemical Corp., Wasatch Div., Brigham City, Utah, for solid-propellant grain core mandrels.
- \$95,400—Goodyear Aircraft Corp., Akron, Ohio, for fabrication and testing of a five-foot-diameter model directional passive satellite.

### ARMY

- \$20,430,915—Western Electric Company (work to be performed in Burlington and Greensboro, N.C.), for production of ground equipment for the improved *Nike-Hercules* air-defense guided missile system. Sharing in the contract funding will be General Electric Co., Syracuse, N.Y. and Steel Products Company, Springfield, Ohio.
- \$1,015,729—Sperry Rand Corp., Sperry Utah Co., Salt Lake City, Utah, publications for the *Sergeant* guided missile system (2 contracts).
- \$396,693—Stolte, Inc., Los Angeles, for technical facilities and missile-handling facilities at Vandenberg AFB, Calif.
- \$212,000—The Martin Co., Orlando, Fla., for *Pershing* weapon system.
- \$79,090—Sperry Rand Corp., Sperry Utah Co., Salt Lake City, for repair parts for *Sergeant* system.
- \$66,387—Giffill Bros., Inc., Los Angeles, for spare parts for the *Corporal* missile system.
- \$42,180—Douglas Aircraft Co., Inc., Santa Monica, Calif., for field change kits and repair parts for *Nike/Ajax, Hercules*.
- \$39,977—Douglas Aircraft Co., Inc., Santa Monica, Calif., for repair parts for *Nike-Hercules* missile.
- \$38,735—Douglas Aircraft Co., Inc., Santa Monica, for aeroballistic engineering services, improved *Honest-John* missile without warhead.
- \$35,188—Douglas Aircraft Co., Inc., Santa Monica, for *Nike* replenishment repair parts, actuator.
- \$25,278—Western Electric Co., Inc., New York City, for replenishment repair parts, *Nike* missile.

### MISCELLANEOUS

- \$4,600,000—Space Technology Laboratories, Inc., Los Angeles, from Sanders Associates, Inc., Nashua, N.H., subcontract for production of broadband power amplifier.

\$800,000—Thompson Ramo Wooldridge Inc., Dage Div., Michigan City, Ind., from General Dynamics/Astronautics, San Diego, Calif., for closed-circuit television equipment to be used in connection with the AF series *Atlas* ICBM program.

\$765,600—Collins Radio Co., Dallas, from McDonnell Aircraft Corp., St. Louis, for horizontal situation indicator equipment.

\$500,000—Ampex Corp., Redwood City, Calif., from Bell Telephone Laboratories, for advanced video magnetic tape recorders.

\$372,000—Sylvania Electric Products Inc., from General Electric Co., Ordnance Dept., Pittsfield, Mass., for production of electronic plug-in modules for the *Polaris* submarine Mark 84 fire control system.

\$325,197—Collins Radio Co., Cedar Rapids, Iowa, from DOD, for electronic equipment for the three services.

\$130,000—Systems Div., Electro-Mechanics Research, Inc., Sarasota, Fla., from Babco Brothers Research Corp., for MICROC POWER PCM telemetry systems for use in the NASA S-17 orbiting solar observatory.

\$110,000—Geoscience Ltd., Solano Beach, Calif., basic research contract from the Atomic Energy Commission in connection with auxiliary nuclear power space system.

### NASA

- \$1,758,258—Hughes Aircraft Co., Hughes Research Laboratories Division, Malibu, Calif., for continued R&D of a cesium powered ion rocket engine.
- \$1,400,000—Republic Aviation Corporation, Farmingdale, L.I., N.Y., for development and supplying of tooling and assembly fixtures for use in production of the *Saturn* vehicle, and also for production of a number of the structural components.
- \$95,000—North American Aviation, Los Angeles, for study of technical feasibility of a large erectible manned space station.

### NAVY

- \$9,556,832—Magnavox Co., Fort Wayne, Ind., for sonobuoys.
- \$2,901,672—General Electric Co., Utica, N.Y., for guidance control equipment for *Side-winder* missiles.
- \$2,404,795—General Electric Co., Pittsfield, Mass., for engineering services in connection with the *Polaris* program.
- \$1,800,000—Westinghouse Electric Corp., Baltimore, for production of underwater launch and sea energy recorder system for use in connection with *Polaris* launching system.
- \$1,000,000—Radio Corp. of America, Camden, N.J., for electronics equipment.
- \$200,000—Hamilton Watch Company, Military Products Division, Lancaster, Pa., for manufacture of safety and arming programs to be used on the *Terrier* and *Tartar* missiles.
- \$49,520—North American Aviation, Inc., Columbus, Ohio, for study to determine or establish the validity of using multiplying factors and/or applied ratios for the design and test of airframe structures subjected to elevated temperatures.
- \$47,820—Rocket-Power Inc., Div. of Gabriel Co., Mesa, Ariz., for rockets, 6 ea.
- \$25,584—Scientific Services Lab., Inc., Dallas, for sub-bottom reflection equipment.



# when and where

## NOVEMBER

**Northeast Research and Engineering Meeting, IRE**, Somerset Hotel and Commonwealth Armory, Boston, Nov. 14-16.

**19th Annual Aerospace Electrical Society Display**, Pan Pacific Auditorium, Los Angeles, Nov. 15-17.

**First Conference on Medical and Biologi-**

**cal Problems in Space Flight, Bahamas Conferences**, Nassau, Nov. 19-24.

**Electron Devices Meeting, IRE**, Shoreham Hotel, Washington, D.C., Nov. 20-21.

**11th Semi-annual Meeting and Midyear Conference of the Manufacturing Chemists' Association, Inc.**, New York City, Nov. 21.

**ASME Winter Annual Meeting**, Statler Hilton Hotel, New York City, Nov. 26-Dec. 1.

**Armed Forces Communications and Electronics Association, Cape Canaveral Chapter**, symposium to be held in Cocoa Beach, March 6-8.

**1962 Symposium on Packaging of Chemical Products**, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, March 13-14.

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## DECEMBER

**Annual International Visual Communications Congress**, co-sponsored by Society of Reproduction Engineers, American Institute for Design and Drafting and the American Records Management Association, Biltmore Hotel, Los Angeles, Dec. 2-5.

**National Aerospace Support and Operations Meeting**, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Fla., Dec. 4-6.

**19th Annual Electric Furnace Conference**, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.

**Eastern Joint Computer Conference**, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C. Dec. 12-14.

**Annual Meeting, American Association for Advancement of Science**, Denver, Dec. 26-31.

**Annual Meeting, American Statistical Association**, Roosevelt Hotel, New York, Dec. 27-30.

## JANUARY

**8th National Symposium on Reliability and Quality Control**, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

**National Plant Engineering and Maintenance Show and Conference**, Convention Hall, Philadelphia, Jan. 22-25.

**Solid Propellant Rocket Conference, ARS**, Baylor University, Waco, Tex., Jan. 24-25.

## FEBRUARY

**Western Electronic Week and Pacific Electronic Trade Show**, Las Vegas and Los Angeles, Feb. 3-11.

**Winter Convention on Military Electronics, IRE**, Ambassador Hotel, Los Angeles, Feb. 7-9.

**International Solid State Circuits Conference**, Philadelphia, Feb. 14-16.

**30th Annual Symposium on Nondestructive Testing of Aircraft and Missile Components** (Southwest Research Institute), Gunter Hotel, San Antonio, Feb. 27-March 1.

## MARCH

**5th Annual Technical Conference, Society of Vacuum Coaters**, Sheraton-Cleveland Hotel, Cleveland, March 6-7.

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## Closing the Weather Gap

**T**HIS WEEK, representatives from 28 nations, including the Soviet Union, are gathering in Washington for an international workshop on the U.S. weather satellite program.

The visitors will tour NASA's Wallops Island station. They will be shown the *Tiros* weather satellite. They will be instructed at laboratory sessions on interpretation of *Tiros* photographs.

They will be briefed on the infrared equipment carried aboard.

Data from all three *Tiros* satellites will be presented and future plans for U.S. meteorological systems will be explained in detail. These include four more *Tiros* launches and the inaugural 1962 launch of the more advanced *Nimbus* program.

Intent of the workshop is to demonstrate this nation's willingness to share the information from its weather satellites with all nations of the world, not excepting Russia.

The program will emphasize one of the most successful U.S. satellite programs, one which is an outstanding example of the peaceful uses of space. All three *Tiros* launches have been successful. Some 70,000 useful cloud photographs have been taken and transmitted to earth.

Practical value of the system was brought out in a recent speech by T. Keith Glennan, president of the Case Institute of Technology and former NASA administrator, before the International Air Transport Association's annual meeting in Australia. He told the airline delegates:

"It seems clear that meteorological satellite systems—which I expect will be operational within five years or less—will provide your operating people with weather forecasts of much greater accuracy and longer lead time than is the case at present . . . It will be an important step forward in the improvement of service and the comfort of your passengers."

As Dr. Glennan pointed out, *Tiros III* conclusively demonstrated its worth in the case of Hurricane Esther, which smashed into the U.S. Gulf Coast two months ago with extensive damage but low loss of life. This was the timetable on the Sept. 10 detection of Esther:

3:10 p.m. EDT. *Tiros III* recorded on command a series of photographs as it passed over the hurricane-spawning grounds in the South Atlantic.

4:34 p.m. Completing another orbit of the earth, *Tiros III* transmitted the pictures as it passed over the read-out station at Pt. Mugu, Calif.

6:00 p.m. Meteorologists of the U.S. Weather Bureau completed their preliminary analysis and telephoned a warning to the National Meteorological Station at Suitland, Md. The satellite had provided

a good "fix" on a suspicious cloud formation at 11 degrees north latitude, 30 degrees west longitude. The Pt. Mugu weathermen then began translating the cloud photos into diagrammatic charts.

7:00 p.m. The Hurricane Warning Center at Miami was alerted to the possibility of the formation of a hurricane.

7:55 p.m. Pt. Mugu completed its diagramming and transmitted the charts by direct facsimile to the National Meteorological Center.

11:00 p.m. Transmission of the diagrams to all principal weather bureaus over the National High Altitude Facsimile System was completed.

Thus, in less than eight hours from the time *Tiros III* took the photographs, they were translated into useful forecasts in the hands of U.S. weathermen.

Two days later, a hurricane-hunter plane entered the storm and verified winds of hurricane force. It was a dramatic demonstration of the value of a weather satellite system.

**F**IRMS SUCH AS Radio Corporation of America, prime and system contractor on the satellite and its instrumentation, Hoffman Electronics, system contractor of the power units, and Douglas Aircraft, prime contractor for the *Thor-Delta* booster, together with the many firms associated with them, can take pride in the fact that the early warning from *Tiros III* was instrumental in the saving of many lives.

Beyond *Tiros* lies *Nimbus*, the second-generation weather satellite on which General Electric is prime. And beyond *Nimbus* is *Aeros*, a system of 24-hour satellites which together with one or more satellites launched into polar orbit will provide continuous observation of the earth's cloud cover.

Data analysis techniques being developed in these programs are leading to a revolution in weather forecasting which will benefit all nations of the world. NASA and the Weather Bureau are to be complimented for the decision to make as much information as possible available at this early date.

We now would like to ask Mr. Khrushchev when he is planning to hold an international workshop on the Soviet Union's "peaceful" space program. When will international delegates be invited to study your satellites and view your launch sites, Mr. Prime Minister?

Your delegates are welcome in Washington and at Wallops Island. When may we expect a return invitation, Mr. Khrushchev?

William J. Coughlin



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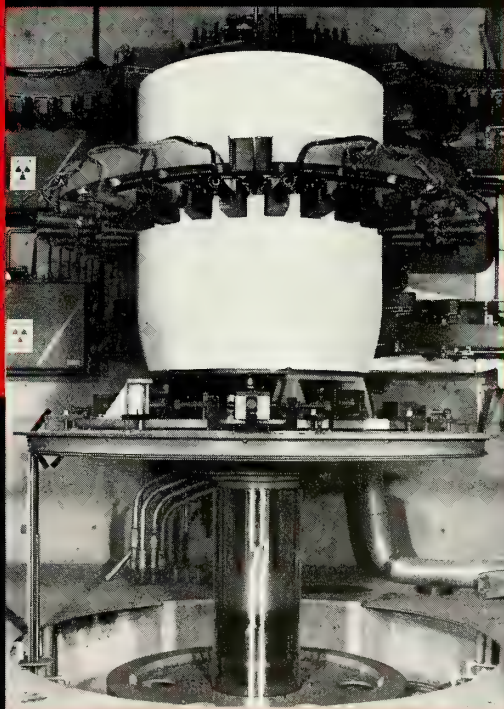
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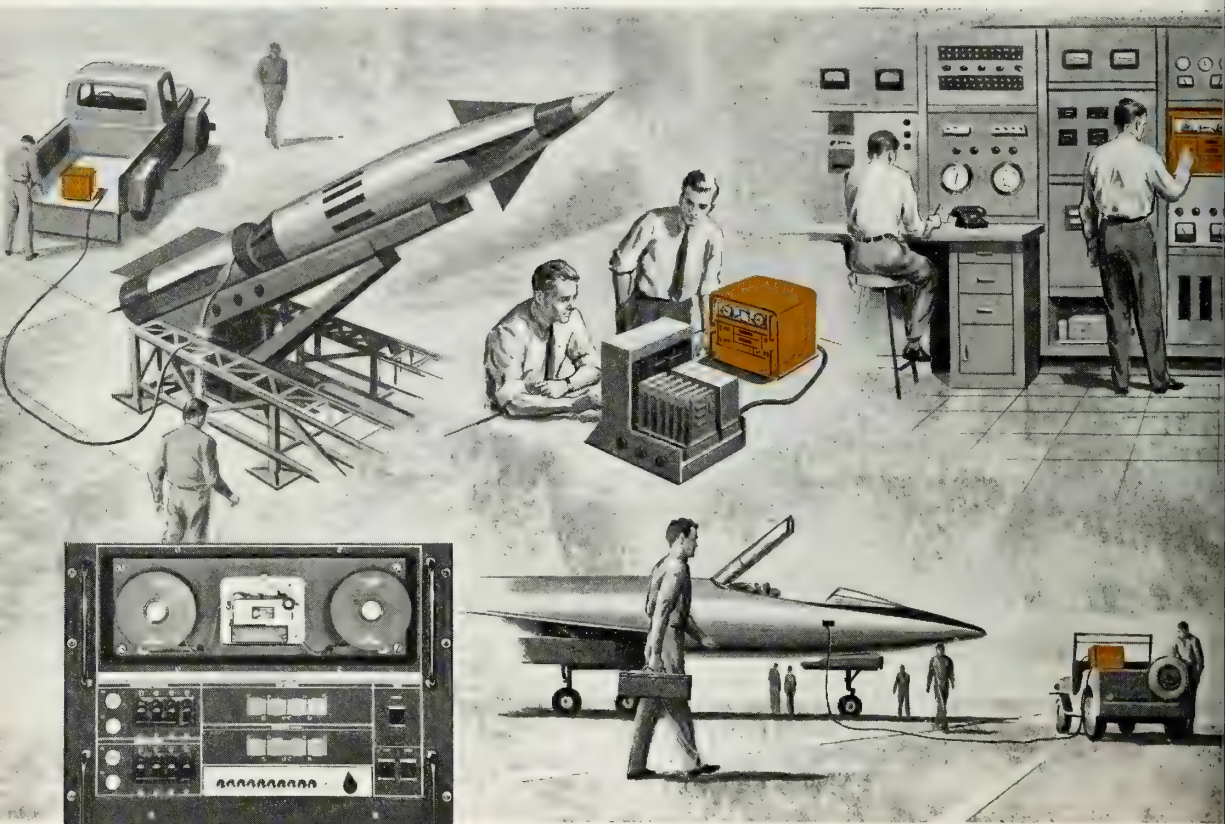
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NOVEMBER 27, 1961

# missiles and rockets

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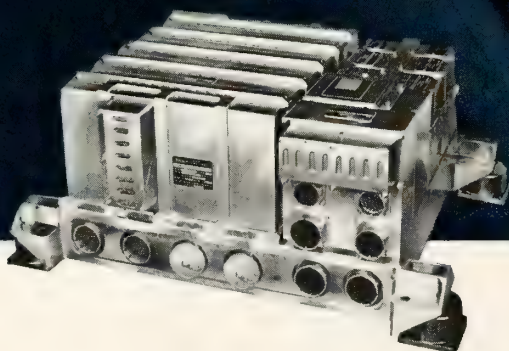
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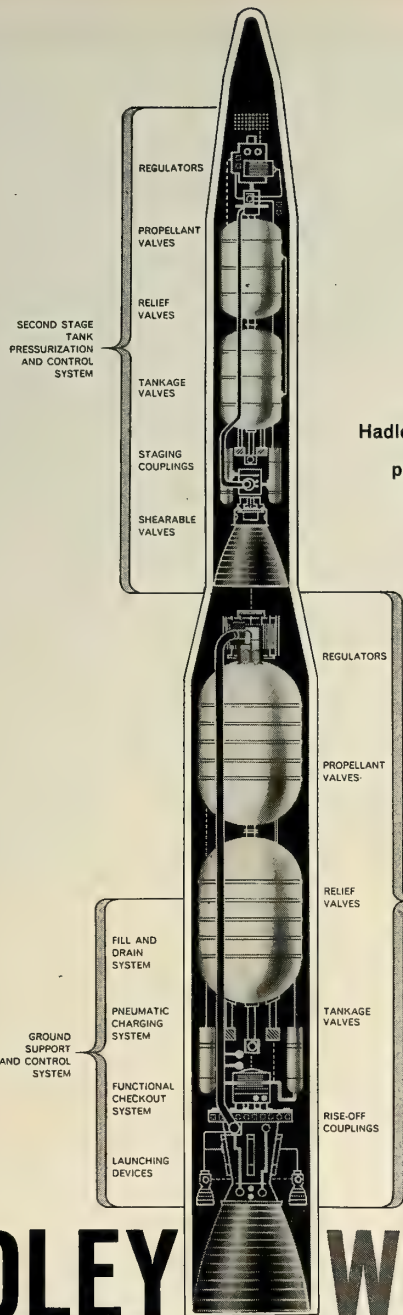
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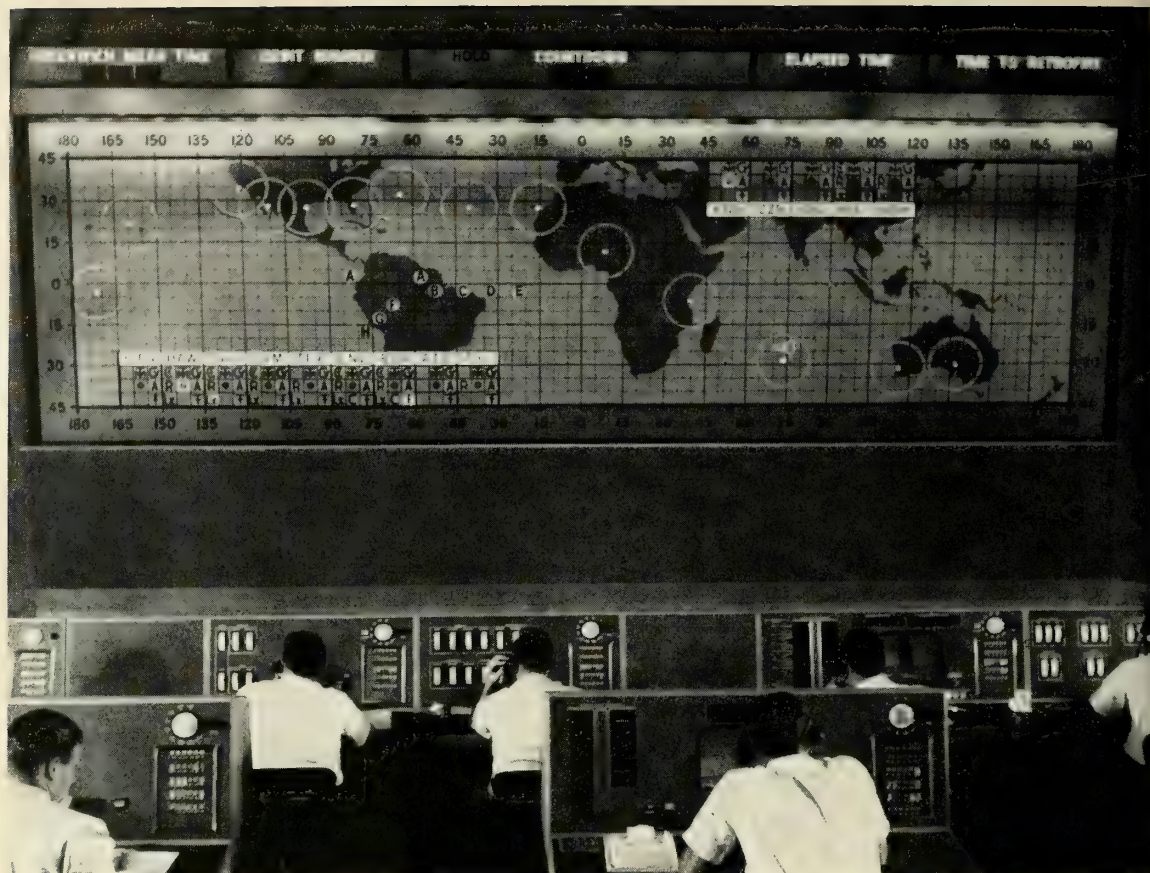
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## Bell System manages building of global communications network for Mercury spacecraft

On September 13, National Aeronautics and Space Administration first achieved the orbital flight of an unmanned Mercury spacecraft, using a new world-wide communications and tracking network.

Soon, will come manned orbital flight.

The Bell System has played a large role in the development of this scientific project.

Western Electric headed an industrial team, on which Bell Telephone Laboratories also played an important part, in building the world-wide network of tracking and monitoring stations.

This 60,000-mile communications route, the bulk

of which is teletypewriter and telephone circuits, ties together 17 tracking and instrumentation sites with the Goddard Space Flight Center in Greenbelt, Md., and the Cape Canaveral Mercury Control Center.

As a Mercury capsule orbits over the area covered by each site, the far-reaching communications network immediately begins feeding information received from the capsule with clockwork precision. So fast and efficient is this communications system, it takes only seconds for data to start flowing from any site through Goddard to Canaveral!

The Bell System is proud to have contributed its creativity and resources to this vital project and to the further advancement of global communications.



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# missiles and rockets

Volume 9, Number 22

November 27, 1961

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## THE COVER

Successful Oct. 27 takeoff of Saturn C-1  
symbolizes NASA's gathering drive toward  
the moon, subject of this First Annual NASA  
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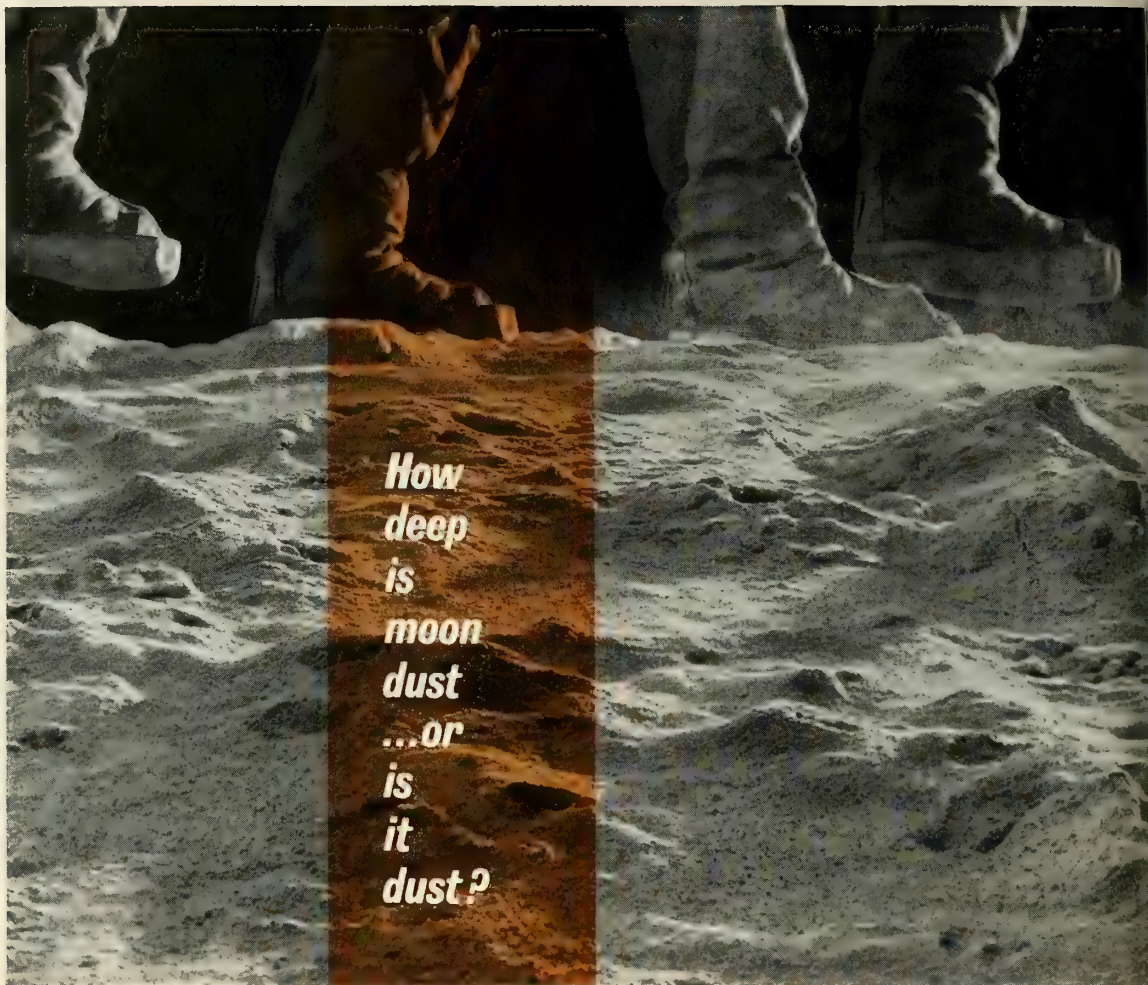
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†U.S. Reg. Pdg.

41,967 copies this issue



*How  
deep  
is  
moon  
dust  
...or  
is  
it  
dust?*

## ***GM's DSD seeks an answer!***

Scientific studies are now under way in GM's Defense Systems Division to determine the most efficient configurations for lunar-roving vehicles. Major factors under investigation include composition of the lunar surface together with the effects of large temperature ranges, lunar gravity . . . no atmosphere or humidity. Research in our Soils Laboratory on probable lunar conditions has led to a number of promising designs. Unusual studies like these, unusual facilities and unusually capable men present a great challenge and opportunity to scientists and engineers who are qualified to make a solid contribution at any level. DSD is now, as always, searching for new talent in these areas.

**Scientific areas now under study:** ■ Aero-Space Operations ■ Sea Operations ■ Land Operations ■ Biological Systems ■ Technical Specialties



**Moon-Roving Concept**—This early model moon rover utilizes the principle of the Archimedes screw . . . and is just one of a number of vehicle types under study for known lunar conditions.



**DEFENSE SYSTEMS DIVISION OF GENERAL MOTORS CORPORATION • WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA**

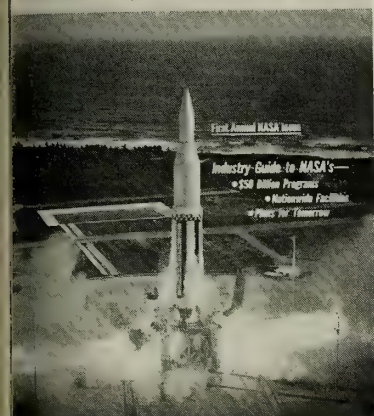


# memo from the publisher

## missiles and rockets

THE MISSILE/SPACE WEEKLY

NOVEMBER 27, 1961



YOU ARE HOLDING the largest weekly issue ever published by this magazine. Its size is indicative of the importance of its subject.

As NASA Administrator James Webb points out on p. 40, the National Aeronautics and Space Administration is engaged in what many people consider the most ambitious endeavor in U.S. history, the effort to land a team of American astronauts on the moon. To achieve this and its other important scientific goals, the space agency within the next few years will be spending an estimated \$4 billion annually with industry.

NASA's growth this year has been explosive, so explosive that many in the industry have found it difficult to keep up with the changes. The large-scale expansion and reorganization of the agency is, however, of prime importance to those who are doing business with it—as well as those who hope to do business with it. We felt one of the most useful tools we could provide for the industry we serve was an up-to-date guide to NASA.

During the past two months, the editors of MISSILES & ROCKETS have been touring NASA installations throughout the nation. Every NASA center was visited, some more than once, some by several editors. Detailed information was obtained on budgets, facilities, programs and procurement practices. The need for new equipment and techniques was explored with the men closest to the programs. You will find in the pages that follow not only useful planning information but a great many little-known facts about the space agency.

Did you know . . .

—That the Ames Research Center uses about 12-million cubic feet of helium a year?

—That every hour *Explorer XII* is in orbit means an hour of data reduction for Goddard Space Flight Center?

—That Langley Research Center can trace its involvement in the missile field from its 1918 experiments with a modified Curtiss-Wright aircraft used as a drone?

—That photographic supplies at Lewis Research Center are purchased by W. T. Hodges?

—That the budget at the Flight Research Center at Edwards AFB is expected to double next year?

—That the cost of launch vehicles for Goddard satellites does not come out of the Goddard budget but out of NASA Headquarters' money?

—That Lewis Research Center is looking for a commercially available alloy which will contain liquid potassium and sodium?

These and many other facts about the space agency are contained in this issue. Every effort has been made to fully inform you on NASA programs and to help you in doing business with an organization that is expected to spend some \$40 billion with the industry in this decade.

Here is one way to use this guide:

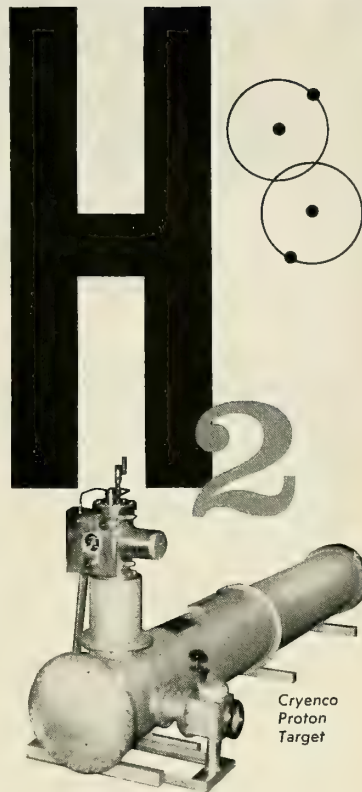
Study the overall NASA budget and its programs in the beginning of the issue. Then if you are, for example, in the electronics field, turn to the section on electronics. There you will find a rundown of what NASA is doing in the electronics field and where. Let us say your particular interest is in data handling. You will discover that there is a major interest in this at the Goddard Space Flight Center, as well as several other centers. Turn then to the individual articles on these centers. They will tell you what each center's budget is, what its facilities are, where its fields of interest lie. Its procurement practices and even the names of its procurement officers are provided.

We believe you will find this issue useful as a reference throughout the year. Combined with the extensive weekly coverage of NASA in the months ahead, it will keep you well posted on one of the government's major purchasing agencies.

Incidentally, it also is worthy of note that with this issue, M/R's net paid circulation passes 35,000—a gain of some 5000 since the first of the year.

*Edward M. Mischfeld*

## CRYOGENICS



Write us for low temperature, high vacuum equipment to use in your liquid hydrogen work!

- Hydrogen Liquefiers
- Hydrogen Cryostats
- Valves and Lines
- Liquid Storage and Transport
- Refrigerators 20° - 30° K

Liquid hydrogen provides an ideal medium for research in the range of 20° - 30° K. Cryenco engineers have pioneered many of the phases of work in this area. Today, these men are available to you for production of equipment and hardware that you need—both standardized and custom built. An example of the background of these men is the fact that Cryenco engineers have worked on all of the major refrigerator-liquefiers used for hydrogen bubble chambers in the free world. A 2,570 watt, 208 liters/hour hydrogen refrigerator-liquefier is now under construction in our plant. Hydrogen dewars and cryostats are being designed and fabricated from small sizes up to railroad tank car capacities. Cryenco men are ready to go to work on your hydrogen equipment problems—free your physicists and engineers for fundamental work. Write for standard equipment catalog, or send us your specific requirements for our quotation.

## CRYENCO

Cryogenic Engineering Co.  
230 W. 48th Ave., Denver 16, Colo.  
Low Temperature, High Vacuum  
Equipment and Engineering

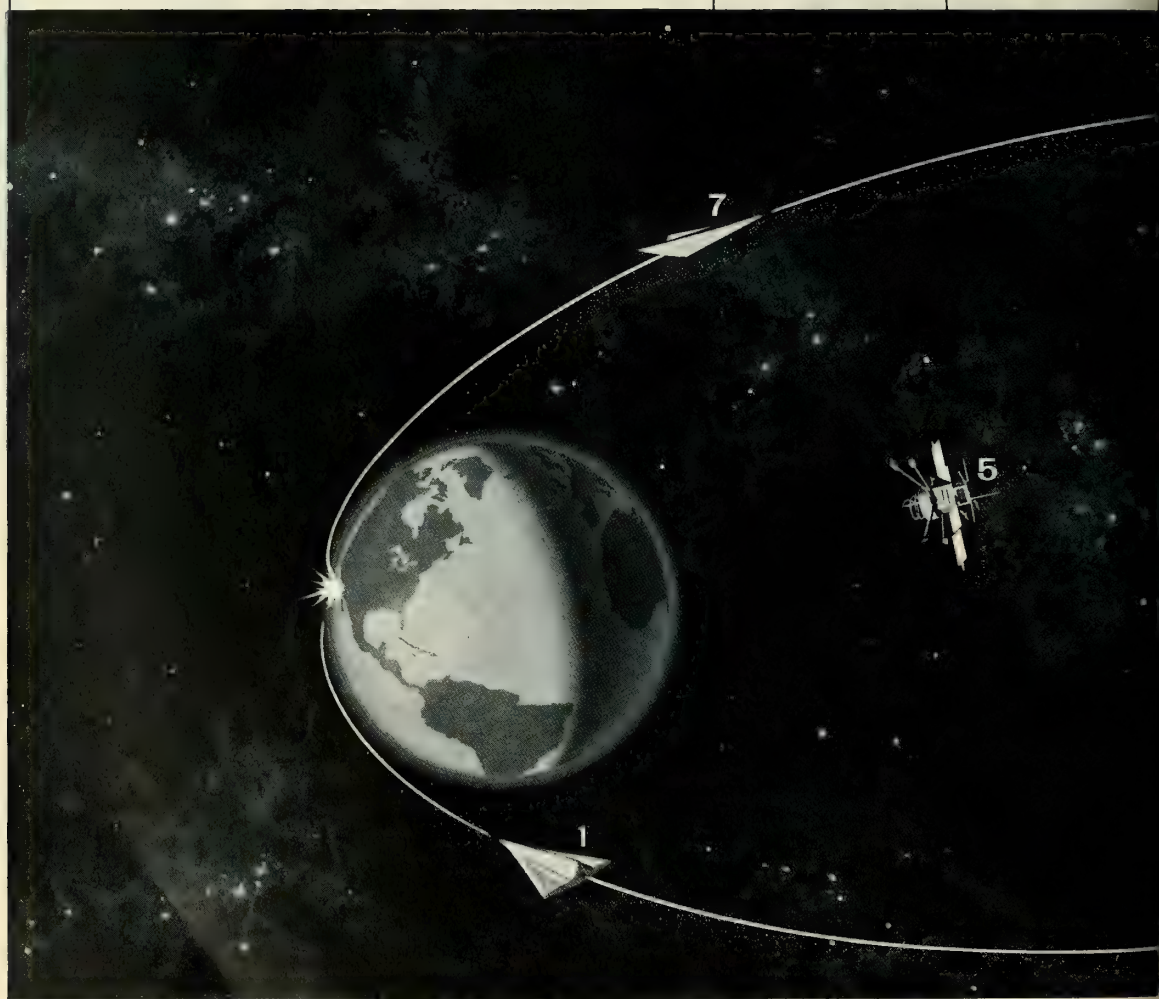
# BENDIX COUNTDOWN FOR SPACE

# 7

**PNEUMATIC CONTROLS:** Hot gas equipment is being developed for space control subsystems using rotary and linear actuation, reaction jets, and pneumatic computation. A complete subsystem is now being built at E-P under USAF contract.

# 6

**SELF-ADAPTIVE CONTROL SYSTEM:** Capable of measuring dynamic sensitivities and adjusting feedback gains in stable fashion without sensing external environment. Automatically blends control of aerodynamic surfaces and reaction jets. Being developed under USAF contract.



## Knowmanship in Action

Technical knowledge, management ability, and craftsmanship all add up to Eclipse-Pioneer's space-age Knowmanship. We pride ourselves on anticipating our cus-

tomers' needs—and meeting them with technical advancements based on specific requirements. The manufacture of precise components and total system capability are typical of our creative ability as a major contributor to the field of space technology. By applying principles of Knowmanship, we're able to



5

4

3

2

1

**SATELLITE CONTROL AND STABILIZATION:** Eclipse-Pioneer has total in-house capability for producing spacecraft attitude-control systems. In production: ADVENT reaction wheels. In development: sun-sensors and star trackers.

**STAR TRACKER SYSTEM:** A system incorporating multiple star tracking heads, designed to operate without a protective dome in the environment of space; digital readout accuracy of  $\pm 5$  arc seconds.

**SPACECRAFT RENDEZVOUS COMPUTER:** Complete solid-state mechanization for analog and digital airborne computation of navigation, guidance, and attitude-control circuitry required at time of rendezvous. Digital computation at 10 megacycle rate.

**ADVANCED DISPLAYS AND CONTROLS:** Development currently in progress. Human-factor display studies directed toward rendezvous, re-entry, energy-management. Electronic and optical devices will present correlated data with minimum panel space.

**LETDOWN, APPROACH, LANDING:** Safer, more reliable letdown and landing systems—such as inertially augmented flare and runway-alignment, computers, advanced instrumentation (including real-time displays)—are now being developed, flight-tested.



...ieve our space mission: research and development  
...tomorrow's intriguing challenges; products for the  
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...TECHNICAL KNOWLEDGE + EXPERIENCED MANAGEMENT  
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**Eclipse-Pioneer Division**



## Liquid vs. Solid Costs

To the Editor:

The article "Costs Bolster Case for Solid Booster" (M/R, Nov. 13, p. 24) considers the problem from an obviously biased viewpoint. This type of cost comparison ignores a principal advantage of the liquid systems over solid systems—the potential economy obtained by recovery and re-use.

There can be little doubt that if boosters are recovered and re-used the hardware cost will become an insignificant factor in the basic costing equations, and the significant parameter for evaluating booster costs in an extensive space program will be the cost of propellants.

Based on present or even extrapolated propellant costs of \$1.00 per pound for solid propellant vs. \$0.5 per pound for liquid propellants, it is apparent that the logical direction for future boosters is towards the development of reliable "air-line type" recoverable liquid boosters.

Despite the fact that this conclusion has been repeatedly confirmed by several investigators, industry effort and government support toward achievement of this goal has remained at a comparatively low level.

B. Friedman  
Eastview, Calif.

## Non-Profit Dilemma

To the Editor:

I thought your Oct. 16 editorial, "Enough of This Non-Profitteering," was well stated. Private industry continues to face the dilemma of coping with more and more non-competitive government-sponsored organizations which do not face evaluation of performance on a competitive basis.

Richard H. Olson  
Vice President  
Sunstrand Corporation  
Denver

To the Editor:

Who will profit from the non-profits? This question is "bugging" industry, the military, and government. Even armchair pundits are waxing eloquent—not to mention the sallow-faced curators of the status quo who automatically condemn anything new.

Depending on who you are, the non-profits are good or they are bad. For instance, industry believes the non-profits will not be able to justify the demand for their "specialized" talents, a demand which was in fact generated by the Air Force. American corporations, particularly the giant missile builders, possess at present adequate systems management capability. Perhaps a supposed preoccupation with stockholders, dividends, new contracts and gross sales, etc., has given government the impression that with industry it's profits first and performance second. Consequently

the Pentagon, doubting the capability of underpaid civil servants and annoyed by profit-taking by systems managers, slaps wrists by attempting to create a corporate utopia; i.e., top-drawer executive talent, big salaries, no stockholders, unlimited capital resources, and complete isolation from the harsh, cold realities of business life. From within this test-tube environment the non-profits have only to provide managerial and technical "advice" to the customer, who pay a fixed fee, regardless of what grade information is being generated.

The Air Force, Army, and even NASA may profit from heeding their respective managerial oracles. After all, many top names and recognized authorities have been lured into the non-profits, hoping perhaps to precipitate a management millennium. They will undoubtedly be right more often than not.

The taxpayer, including aforementioned pundits and curators, will take another financial flogging if only because the non-profits are one hundred percent overhead.

The biggest loss to be incurred as a result of non-profititis is that of public confidence in the free enterprise system which, according to the latest propaganda, will catch and over take the largest and most "profitable" non-profit organization the world has ever known.

If, in fact, industry has been found deficient in producing "state-of-the-art" management teams, it should take stock immediately and place added emphasis on this phase of space systems creation. If on the other hand industry is being unjustly by-passed by the armed services who, goaded by traditional rivalries, are trying desperately to "outmanage" each other, the Pentagon should step in and override this senseless stockpiling of management talent and return systems management to private enterprise where it belongs.

Walter H. Trask  
Santa Clara, Calif.

To the Editor:

I always read your editorial, since your un-gimballed position, whether one agrees with it or not, is at least refreshing. Occasionally, I find one which is even less interesting than the self-backslapping advertisements so profusely displayed in M/R's pages. "Enough of This Non-Profitteering" (M/R, Oct. 16), however, was fine. I hope your well taken point is equally well taken by those in charge.

Jack F. Cully  
Albuquerque, N.M.

## Trieste Gets Its Data

To the Editor:

With much pleasure we have received 25 copies of your very interesting Annual Missile/Space Encyclopedia, and we thank you very much for your kindness and splendid gesture.

For your information, we have sent

copies to 23 of the better students of our astronautical course. . . . Two copies will remain in this Center to assist us in our studies.

We have received from the following persons and organizations many offers of pamphlets, technical books and data:

1. NASA's George C. Marshall Space Flight Center (Mr. W. H. Stafford sending a very important technical note about satellite launchings).

2. NASA Headquarters, publications, photographs and books.

3. Mr. Donald J. Ritchie, supervisor mathematician, vice-chairman of the Institute of the Aerospace Sciences, sending a very nice and interesting booklet on design of ballistic rockets.

4. *San Diego Union*, asking for a copy of the Russian book (from which we earlier obtained drawings and data on U.S. missiles).

5. Mr. Chester Zeich, ARS member, asking information about our course.

6. Mr. Horace Westbrook, asking for a postal stamp of Italian firing rockets, for a philatelist.

Hoping you are pleased, I thank you again very much for your interest in our organization.

Fabio M. Berto  
General Secretary  
Astronautics Sciences and Space  
Technology Diffusion Center  
Trieste

Mr. Berto first wrote M/R (Sept. 4 issue, p. 52) to ask for help in obtaining information on U.S. space programs. He said that USIS in Trieste had been unable to supply such material. Lowell Bennett, Director of the Office of Public Information, U.S. Information Agency, wrote a letter in reply (M/R, Oct. 23, p. 7) detailing the lectures, films, photos and pamphlets on U.S. space activities that his agency had provided in Trieste and elsewhere in Italy. We don't know why Mr. Berto and USIA had their difficulty, but we are glad in any case that the Diffusion Center is accumulating more information.—Ed.

## Dots and Dashes

To the Editor:

Mr. J. B. Wilson's letter to the editor (M/R, Oct. 30, p. 6) appeared quite logical and straightforward until my mental arithmetic failed to come up with the same answers that he obtained. Initially it appeared that the ratio for take-off thrust to take-off weight in Soviet boosters given as 1—3 may have been inverted preventing me from taking off. After wondering if Mr. Wilson really knew what he was talking about it finally dawned that M/R's proof reader had caused the problem by replacing the decimal point in 1.3 with a dash.

Robert T. Carr  
Cmdr USN  
Executive Officer  
Naval Space Surveillance System  
Dahlgren, Va.

(Continued on page 181)





## He's solving a real estate problem

This AMF engineer's job is determining how best to move big missiles off shore for launching. Should they be floated out horizontally, flooded to an upright position, and then launched? Or, would it be more feasible to barge them out? Might they be moved to or assembled on "Texas Towers," or would a causeway or simply land-fill be the answer?

Behind the project is our shrinking real estate at launching sites, plus the hazards inherent in launching Saturn-sized missiles (and the coming, nuclear-powered missiles) near other installations. Off-shore launching may be the answer.

Feasibility studies of all types are an AMF specialty. What kind of remotely controlled machinery is required to service nuclear-powered aircraft? What kind of habitation could be built on (or under) the surface of the moon? What sort of machines (manned and unmanned) could survey the moon's surface without, for example, falling into a fissure? What is the best way to assemble a space station? All these are problems AMF engineers are presently investigating.

If your problem is the first of its kind, AMF will not, of course, have met it before. But AMF's long experience in accepting totally unique challenges gives it an advantage enjoyed by few other organizations concerned with ground support, launchability and space environment. To get further information write American Machine & Foundry Company, 261 Madison Avenue, New York 16, N. Y.



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# "TIME IS THE SCARCEST RESOURCE ESSENTIAL TO THIS COUNTRY'S SPACE EFFORT"

Dr. Edward C. Welsh / exec. sec. / National Aeronautics and Space Council / N. Y. Times, Oct. 8, 1961

HALLAMORE has smashed the TIME BARRIERS with Space-proved Hardware...Others talk about design capability.

Hallamore proves it with products "off the shelf," proved on key NASA programs. Time barriers were smashed in the original development and production.

Time can take another licking when you apply space proved Hallamore hardware to your newest challenge. 1. Spaceborne TV for project Centaur...

observes interior of liquid fuel tanks during flight. 2. Spaceborne

TV for project Echo...monitors opening of balloon from mount aboard final missile stage. 3. Closed Circuit TV for project Saturn...

explosion-proof camera is part of Hallamore system observing blast on test stand and launch pad. 4. S-Band Receiving

System for JPL Deep Space Instrumentation Facility, DSIF,

Goldstone...four basic subsystems: Three-channel

Monopulse Receiver, Ranging RF Equipment, Doppler Extractor and Transmitter Exciter. 5. Instrumentation & control system,

joint project with Bechtel...Liquid

Hydrogen Engine Test Stand Complex

and Blockhouse facilities at

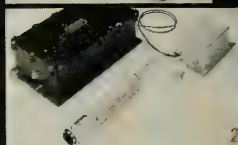
George C. Marshall Space

Flight Center.

**HALLAMORE**

Electronics

Division





# The Countdown

## WASHINGTON

### NASA 10-Year Plan—Revised

Officials at NASA are putting together a radically updated version of the old 1960 NASA 10-year plan for exploration of space. The plan—scheduled to be ready for submission to Congress in January—will take into account the great acceleration of the Manned Lunar Landing Program that is pushing the expected date of reaching the moon up to 1967, instead of the early 1970's.

### Polaris Sub Goal Rising

The Navy appears to be raising its long-range goal for the *Polaris* fleet. Until recently, the magic number has been a total of 45 *Polaris* submarines. Now the number is being tentatively raised to 50. That would give the Navy a total of five nine-ship squadrons and possibly five additional submarines for NATO.

### Mercury Monkey Shot Readied

The launching of a monkey-carrying *Mercury* capsule into orbit has been rescheduled for sometime within the next week. Some Administration officials are understood to have proposed that the shot be skipped and that a manned capsule be launched instead. But the proposal has been rejected. As a result, the earliest a manned capsule could be launched is mid-January. February is a more likely date.

### Zeus 3-Stage Launch Coming

The first hot launching of all stages of a *Nike-Zeus* now is expected to take place by the end of the year. So far, only two stages of the three-stage antimissile missile have been fired in test launchings from Pt. Mugu, Calif., and at White Sands. The three-stage launching will take place at Pt. Mugu.

### LAW in Production

LAW antitank missiles are beginning to roll off the production line. The Hesse-Eastern missile is the newest of the Army's light, solid-fueled tactical weapons. It is expected to be deployed with troops in the near future.

## INDUSTRY

### Hercules to Get Polaris A-3 Award?

COUNTDOWN hears that Hercules Powder's Allegany Ballistic Laboratory has beaten Aerojet-General in the competition for the *Polaris A-3* second-stage production contract. Announcement of the award is imminent. Hercules proposed a glass filament-wound case to help boost the range of the bird to 2500 miles.

### Gel Solid Contract Expected

The Air Force is expected to award a feasibility contract to Atlantic Research for work on the company's gel solid concept. The contract would be part of the Air Force's expanding interest in solid propulsion. Atlantic Research's gel solid propellant is designed so that it can be transported to a launching pad by tank truck and poured into motor cases.

### Electronics Shopping List Due

The Pentagon's new Defense Supply Agency is expected to have a decision by early next year as to what electronic components it will buy for all military services. A proposed "shopping list" for DSA is being put together by a special study group headed by Air Force Maj. Gen. Charles Root. The list is scheduled to be submitted to the Defense Department about Dec. 1.

### Front Office Intelligence

Former Navy Assistant Controller Norwood P. Cassidy has taken over as head of Servonics Inc., Alexandria, Va. . . . North American's Space and Information Systems Division is adopting the Navy's computerized PERT (Program Evaluation and Review Technique) for all major contracted and in-house programs. First use: NASA's *Saturn S-II* stage. . . . Litton is acquiring Aero Service Corp., a \$10-million photogrammetric and geophysical survey concern. . . . After losing its second BIOS capsule in the Pacific Nov. 18, NASA posted a \$25 reward to anyone finding it washed ashore. The capsule is worth \$250,000.

## INTERNATIONAL

### AS 30 vs. Bullpup (Cont.)

Backers of France's *AS 30* air-to-surface missile are contesting reports (COUNTDOWN, Nov. 6, p. 9) that *AS 30* appears to have lost out to *Bullpup* as armament for the NATO F-104 fighter. They claim *AS 30* compatibility tests are "progressing satisfactorily" with the aircraft and no trouble is expected in firing tests to be held shortly. Moreover, they say *AS 30* has the edge with Britain's RAF, West Germany's Luftwaffe and the French Air Force.

### Moving Westward

An advance space projects group dropped by Hawker Siddeley earlier this month may head for America. Dr. William Hilton and several members of his team are expected to take positions with Hughes Aircraft.

### Rumors from Russia

There are reports from Moscow that the Russians now expect to try a manned circumlunar flight early next year—and that they are pushing for a manned landing on the moon in 1964.

# SCHOOLROOM FOR ASTRONAUTS



On America's drawing boards and in the laboratories are two, three and five-man spacecraft, space platforms and manned lunar craft. The goal is interplanetary flight. Eventually, lifetimes may be devoted to a single space adventure.

But man must conquer near space before he goes afar.

Ready to serve as the trainer for future astronauts is NASA's Project Mercury spacecraft. This compact, one-man vehicle now carrying the first Americans into space is an astromedical laboratory to test man's reactions to this new environment. But the Mercury spacecraft can easily serve as a readily available and efficient

schoolroom for future astronautics students making their first leaps into space.

Months of ground training will be necessary for coming space explorers. Then will come trajectory flights to experience weightlessness and spacecraft control. Earth-orbital flights will acquaint the future astronauts with spacecraft control, celestial and ground observation, re-entry techniques, artificial atmosphere and other environment concepts.

Only after he has mastered the "one-room schoolhouse of the space age" will the astronaut be ready to man a deep space vehicle.

## MCDONNELL

Employment opportunities exist for engineers and scientists. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin. Write: Professional Placement, McDonnell Aircraft, St. Louis 66, Missouri.



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Project Mercury, Aeroballistic and Re-entry Research Spacecraft • Talos and Typhon Airframes •  
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## somewhere west of $\alpha$ Centauri...

The mysteries of space . . . untapped resources of limitless knowledge defying existing concepts of the physical and social sciences . . . soon to alter man's image of self and the universe.

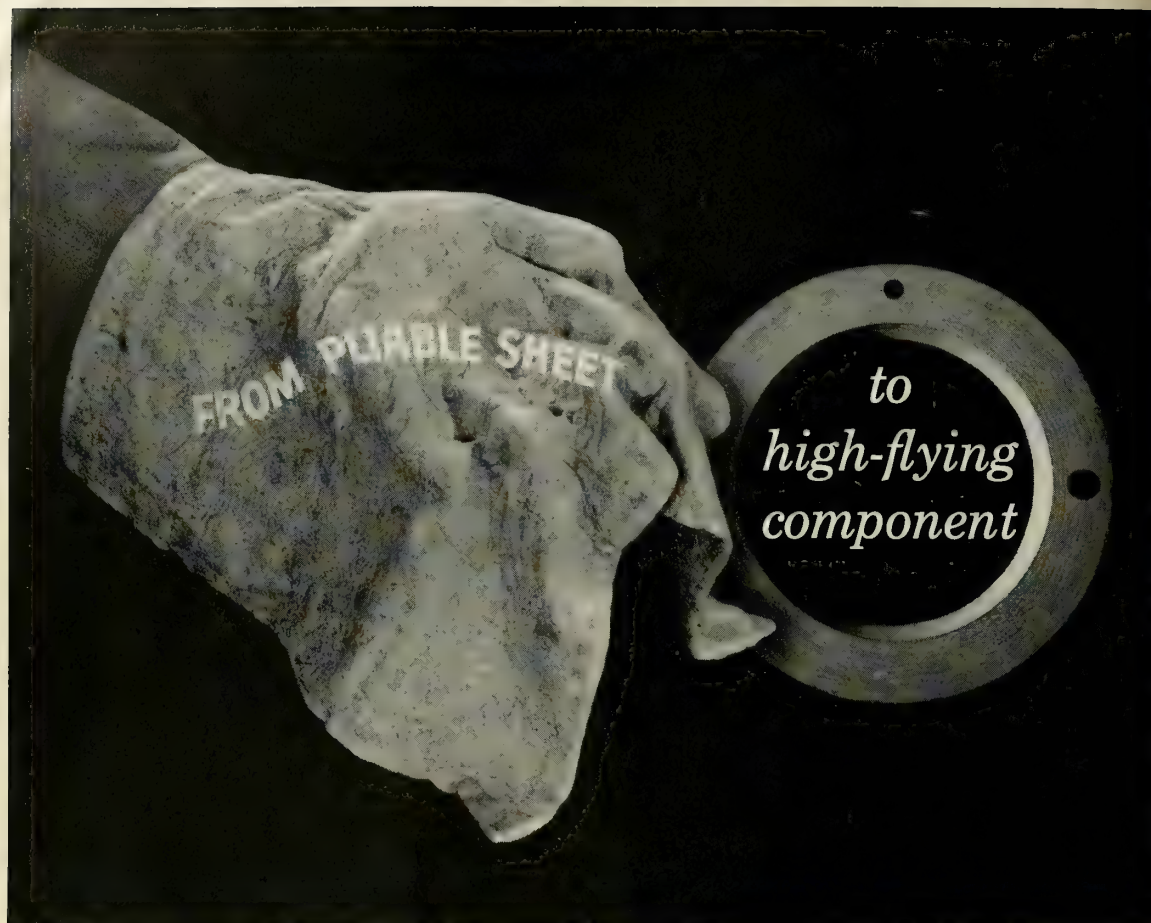
Intra-galaxial communications, sensing, and processing systems developed by ITT Kellogg support the space program's approach to the myriad ramifications of present and long range space exploration.



### **KELLOGG • communications systems department**

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Chicago 24, Illinois

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## Parts molded of J-M Thermomat® meet the extreme service demands of the missile age

Here is a unique new molding compound in sheet form that offers many advantages in rocket and missile applications. Cured parts and components molded of J-M Thermomat—such as the collar you see here—have already proved they can meet the most extreme service demands.

Because these parts withstand high temperatures, offer maximum resistance to ablation and erosion... they are currently being used as an erosive flame shield for protecting critical guidance and stabilizing mechanisms on operational missiles.

Thermomat's high strength-to-weight ratio is another important advantage, permitting rocket weight to be reduced and fuel capacity increased. Thermomat parts also have a high modulus of elasticity.

In sheet form, this non-woven as-

bestos-phenolic molding compound is unusually conformable and pliable, making assembly quicker and easier. Molders like the way joints and seams work together as readily as putty... and the fact that one man can handle lay-up, saving hours of time.

Non-fillouts are at an absolute minimum, even on complex configurations. Asbestos fibers are free-flowing during molding, resulting in a uniformly reinforced part. This versatile product lends itself to both low and high press molding cycles, thus keeping inventory and waste to

a minimum. Any machining of cured Thermomat parts to precision tolerances can be easily accomplished with standard metal-working equipment.

Thermomat is supplied in sheets 14" wide... approximately 12' long... and  $\frac{3}{16}$ " thick. Thermomat in other dimensions may be supplied on request. Molders are invited to write for Technical Bulletin TX-10A and a generous free sample in order to try this remarkable molding material for themselves. Write Johns-Manville, Box 359, New York 16, N.Y. In Canada: Port Credit, Ont.

**JOHNS-MANVILLE**  
THERMOMAT



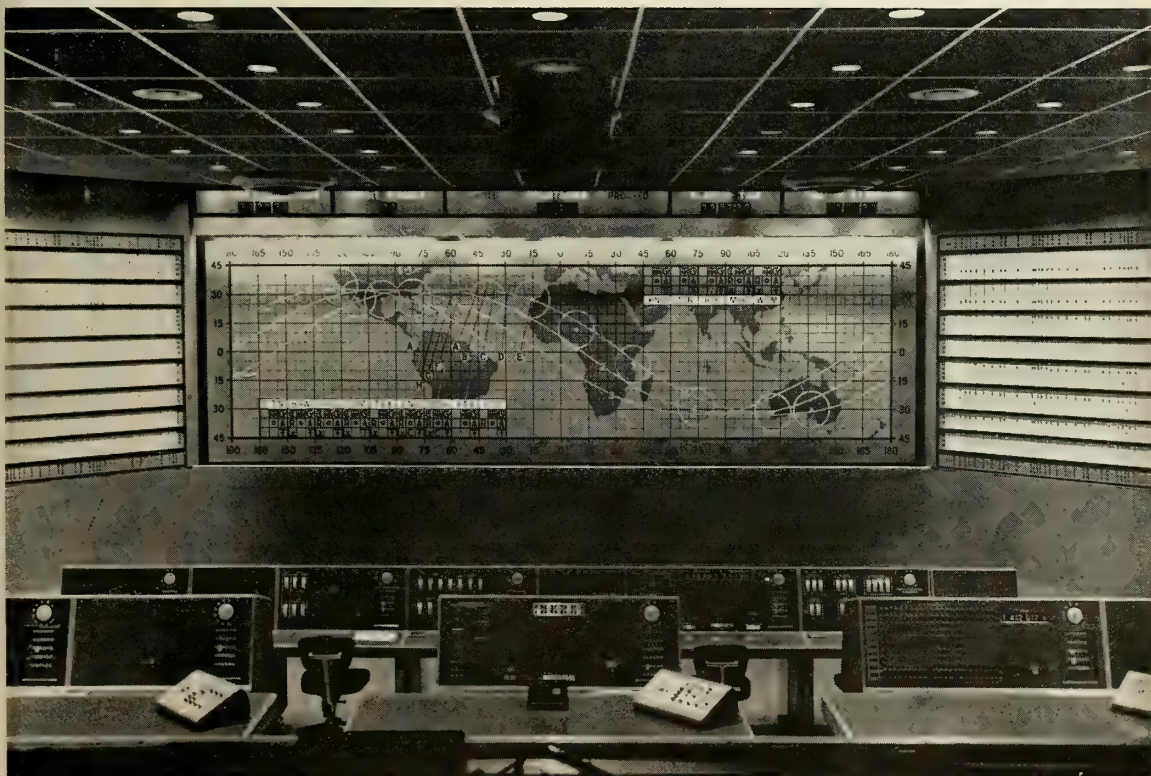


*Lifeguard station for a*



# MAN IN SPACE

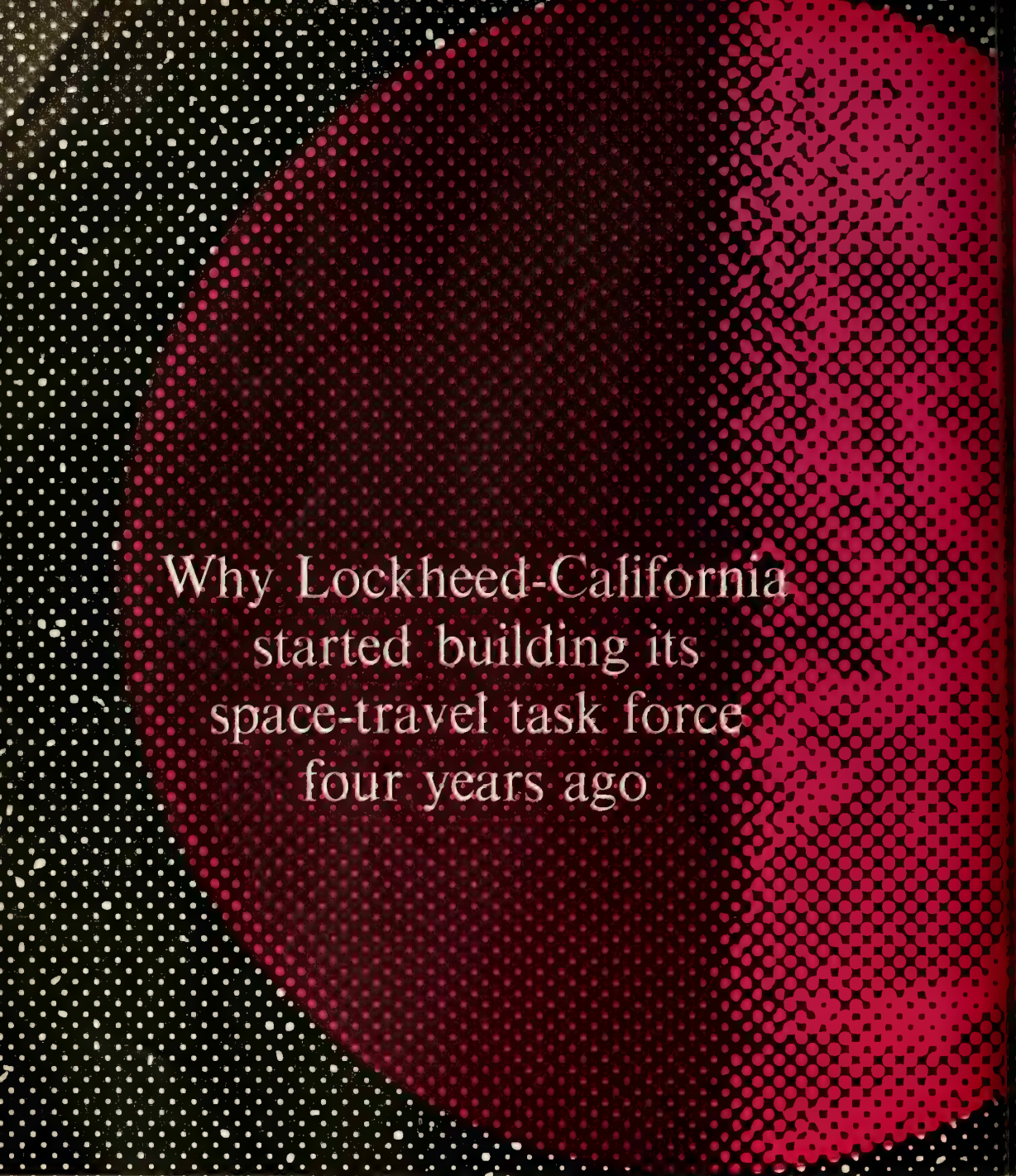
The vital Cape Canaveral nerve center for Project Mercury, the U.S. program to put a man in space, was designed and built by General Dynamics | Electronics. ■ Display information about flights is fed to the operations room from computers and from a world-wide network of tracking and telemetry stations. One wall of the 40 by 60 ft. operations room is a large map display, visually summarizing all pertinent information about the flight. It shows the capsule moving along its orbital flight path around the earth and will also show the location, range and status of all ground based equipment and communications links. ■ The operations room contains display consoles presenting information to the Flight Director, Chief Flight Surgeon, Capsule Communicator, Flight Dynamics Officer and other decision-making personnel. ■ For information on how General Dynamics | Electronics can help solve your data/display problems, write to Dept. B-68, Information Technology Division, General Dynamics | Electronics, 1895 Hancock Street, San Diego 12, California. Telephone CYpress 8-8331.



**GUID**

**GENERAL DYNAMICS | ELECTRONICS**





## Why Lockheed-California started building its space-travel task force four years ago

Back when satellites started making the headlines, it was clear that *man* in space was *next*—and that it would take a lot of groundwork to develop the capability to put him there.

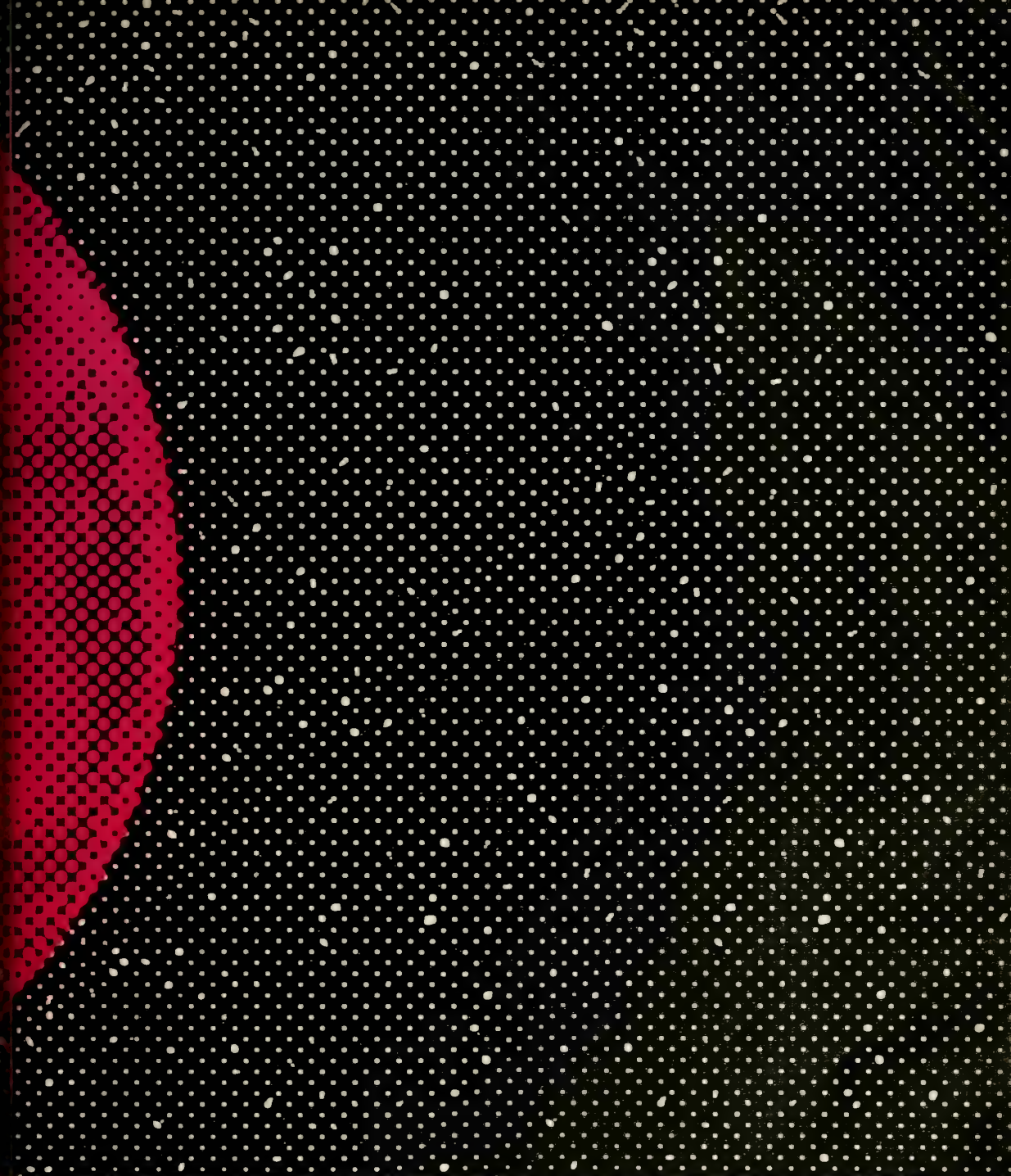
That's why four years ago Lockheed-California anticipated this need and formed its SpaceCraft Organization—the group that has grown into one of today's specialized and knowledgeable man-in-space task forces.

From the beginning, the Lockheed-California Space-Craft Organization has devoted its efforts specifically to the

problems of transporting *men* from one point to another in space. This called for capability in almost every phase of space technology—solar physics, geophysics, astrophysics, biophysics, and radiation hazards—as well as the development of space vehicles and manufacturing techniques.

Today, the Lockheed-California SpaceCraft Organization stands 700-strong—experienced and ready to undertake important projects of the man-in-space age. This group has already made significant contributions to space-





craft technology such as the original Space Ferry concept, SLOMAR/SMART projects, and other major orbital vehicle concepts. Unique man-in-space manufacturing techniques of the Lockheed-California SpaceCraft Organization include the development of high-strength, lightweight, radiation-cooled spacecraft structures.

For more information about the Lockheed-California SpaceCraft Organization, write Mr. Robert A. Bailey, Lockheed-California Company, Burbank, California.

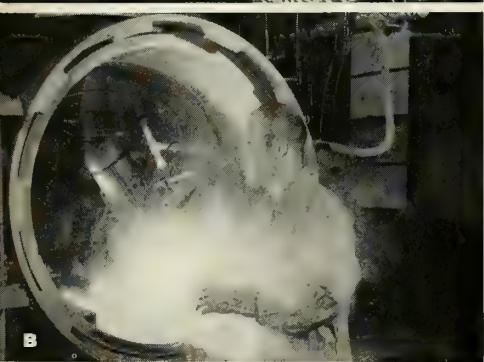
# **LOCKHEED** **CALIFORNIA** **COMPANY**

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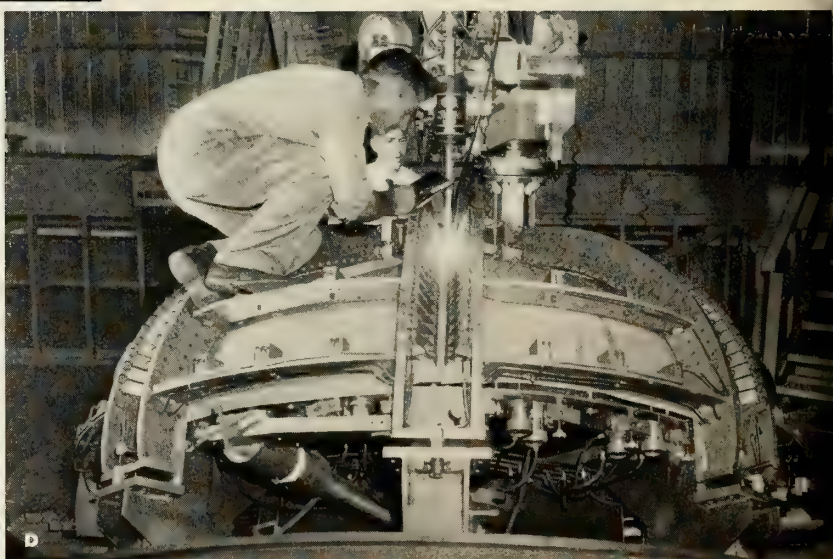
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**Precision welding systems ...  
Cryogenic gases ...  
Applied research ...**

# **Air Reduction helps to speed America's Space Programs**



In America's development of both space vehicle fleets and the new defense arsenal Airco's part is wide ranging, complex, continuing. It includes not only the supplying of gases, equipment and know-how for the projects noted here, but also many other assignments . . . such as the development of a life support breathing system for astronauts . . . the production of gases 99.998% pure for semiconductor crystal growing furnaces . . . the engineering of radical equipment for high precision, high speed joining of metals. If you design or build spacecraft, rockets, missiles, aircraft, or ground support systems . . . Airco can provide constructive help.



## **AIR REDUCTION**

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**A Airco's electron beam welder** is opening new avenues of application for the exotic metals. These metals — columbium, molybdenum, tungsten and other refractory metals have been hard to weld. Now more and more companies engaged in aerospace programs are discovering that these unusual metals yield excellent fusion welds under the high efficiency bombardment of the electron beam welder.

**B Airco nitrogen for Cryogenic valve testing.** To help assure the efficiency of liquid oxygen valves for missiles, Stewart-Warner utilizes Airco liquid nitrogen in its environmental test chamber. Airco's long experience in environmental testing and the high purity of Airco products have led to a manyfold increase in demand for the company's gases.

**C Reaction-control simulator** developed by Boeing Airplane Company to help provide the "feel" of a space vehicle in flight. In this, one of many aerospace applications of Airco gases, blasts of Airco nitrogen from jets slowly pitch, roll and yaw the simulator.

**D The mighty Titan.** Airco's now famous dome welding equipment joining the thin aluminum "orange peel" sections of the Titan's fuel tank top. Designed and engineered by Air Reduction's Special Products Department for the Martin Company, it is the largest precision tool installation in the United States.

**E 1/20/61 launch of the Titan** at Patrick AFB, Florida. Paneled skin of the first and second stages was Airco Heliwelded. Similar Airco equipment is finding broad application in the aerospace field.



# LE 2

Air Products pioneered in the application as well as the production of liquid hydrogen . . . the ultimate fuel . . . for missiles and rockets. Examples: the test facilities for KIWI, and test facilities for even newer missiles. Air Products possesses missile propellant system capabilities few others can match. If you have a problem in propellant systems, look to Air Products first for the answer.

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DEFENSE & SPACE DIVISION: General Office: Allentown, Pa. DISTRICT LOCATIONS: Dayton, Ohio; Washington, D. C.; Los Angeles, Calif.; Orlando, Florida.

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A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

## NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

### TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

### THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to this long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth's cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

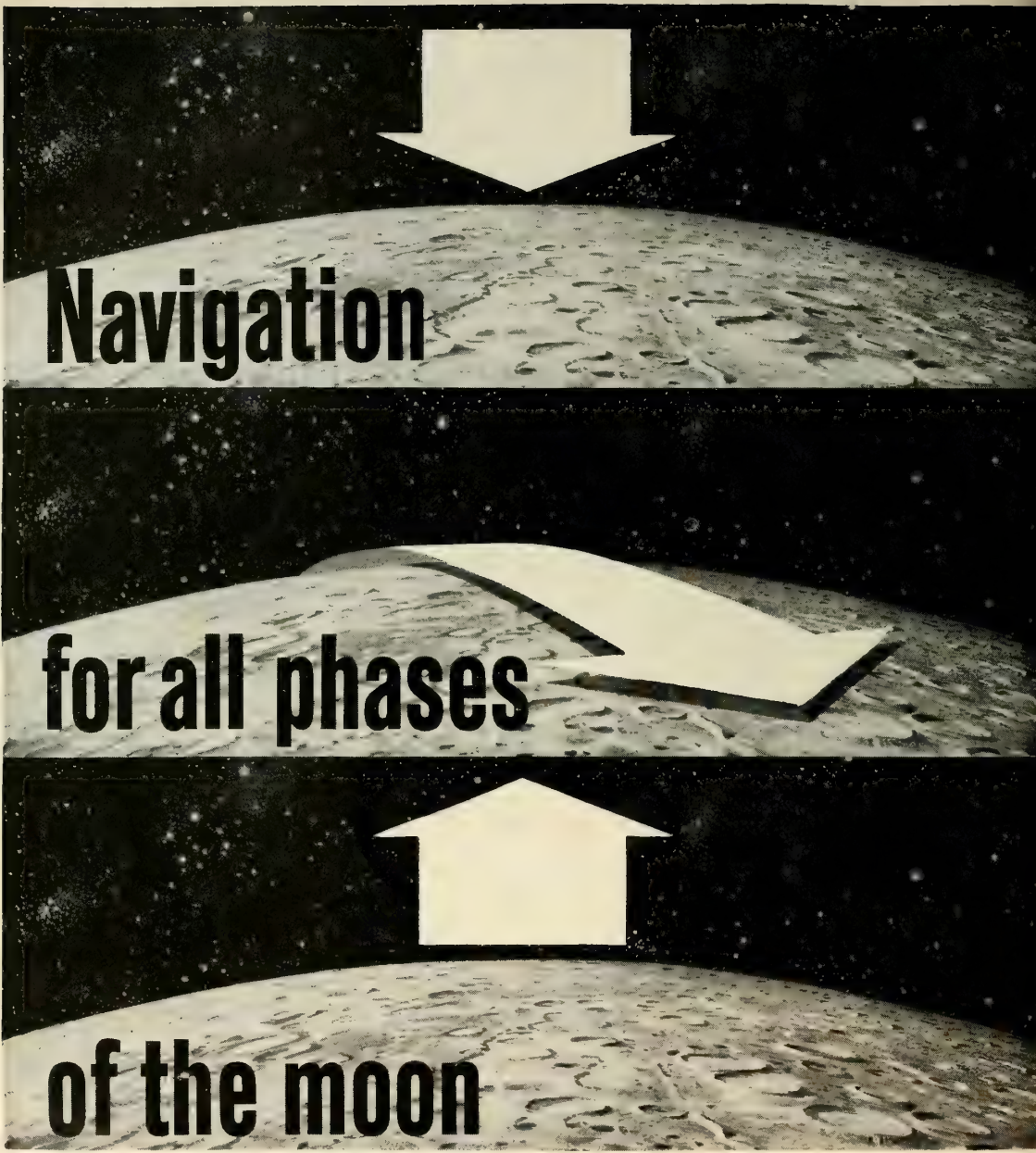
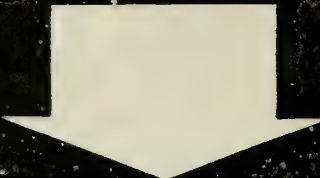
### CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation of meteorological satellites.

Latest RCA Defense Electronics accomplishment—an RCA 110 computer has been procured by NASA from RCA Data Systems Division, Van Nuys, California, to check out SATURN test vehicle. The most challenging opportunities in space electronics are at RCA. Contact Employment Manager, RCA Defense Electronics Products, Camden, N. J.



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# Navigation

## for all phases

## of the moon

"Manned lunar probe" means a successful round trip . . . and poses a host of problems. Among others, navigation.

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ularly the tougher ones of rendezvous guidance, mid-space station assembly, movement over the surface of planets, return vehicle remote launch, recovery and landing — the Sperry Rand Systems Group offers a maximum technological and management capability.

This capability includes deep space tracking radars, rendezvous, orbital and mid-course injection nets, space command and control

centers, attitude control systems, real time data processing, and sophisticated recovery systems to guide a vehicle through the difficult final approach, controlling its speed and maneuvering it to a precise landing site. Other systems include optical communications and navigation, pilot displays and controls, auxiliary power and automatic checkout. General Offices: Great Neck, New York.

# SPERRY RAND SYSTEMS GROUP



# National Aeronautics and Space Administration



*"Now is the time to act, to take longer strides, time for a great new American enterprise, time for this Nation to take a clearly leading role in space achievement. I believe that the nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to earth."*

The President  
of the United States  
May 25, 1961

*The nation has committed itself to accelerate greatly the development of space science and technology, accepting as a national goal, the achievement of manned lunar landing and return before the end of the decade. This space program will require spending many billions of dollars during the next ten years.*

**NASA** directs and implements the nation's research and development efforts in the exploration of space. The accelerated national space program calls for the greatest single technological effort our country has thus far undertaken. Manned space flight is the most challenging assignment ever given to mankind.

**NASA** has urgent need for large numbers of scientists and engineers in the fields of aerospace technology who hold degrees in physical science, engineering, or other appropriate fields.

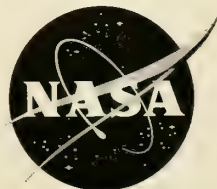
**NASA** career opportunities are as unlimited as the scope of our organization. You can be sure to play an important role in the United States' space effort when you join NASA.

**NASA** positions are available for those with degrees and experience in appropriate fields for work in one of the following areas: Fluid and Flight Mechanics; Materials and Structures; Propulsion and Power; Data Systems; Flight Systems; Measurement and Instrumentation Systems; Experimental Facilities and Equipment; Space Sciences; Life Sciences; Project Management.

**NASA** invites you to address your inquiry to the Personnel Director of any of the following NASA Centers: NASA Manned Spacecraft Center, Hampton, Virginia; NASA Goddard Space Flight Center, Greenbelt, Maryland; NASA Marshall Space Flight Center, Huntsville, Alabama; NASA Ames Research Center, Mountain View, California; NASA Flight Research Center, Edwards, California; NASA Langley Research Center, Hampton, Virginia; NASA Wallops Station, Wallops Island, Virginia; NASA Lewis Research Center, Cleveland, Ohio; NASA Headquarters, Washington 25, D. C.

Positions are filled in accordance with Aero-Space Technology Announcement 252B.

All qualified applicants will receive consideration for employment without regard to race, creed or color, or national origin.



# Chrysler May Build 50 S-I Boosters

NASA launched its *Saturn S-I* booster production program last week with the award of a multimillion-dollar contract to Chrysler Corp.

The initial contract to Chrysler calls for building 20 of the clustered 1.5-million-lb.-thrust rockets for more than \$200 million.

However, insiders estimate the production run may hit 50—running up the contract cost. (The cost-plus-fixed-fee contract extending through 1966 is the first in a series of key contracts in the *Apollo* Manned Lunar Landing Program detailed on page 46 of this special NASA issue.)

NASA announced the contract award Nov. 17, ending a hot competition among seven missile/space firms. The winning Chrysler proposal

includes assistance from Aerojet-General Corp. in static testing of stages. Aerojet also will provide launch support at Cape Canaveral.

Other competitors for the big prime contract were Boeing, Ling-Temco-Vought, Ford Aeronutronic, Avco, Northrop and Lockheed.

The *S-I* boosters are powered by eight Rocketdyne (North American Aviation) H-1 engines. The booster is 81 ft. high and 22 ft. in diameter.

The first 10 *S-I*'s are being fabricated for testing at NASA's Marshall Space Flight Center, Huntsville, Ala. These are the prototypes of the *S-I*'s which Chrysler will produce at NASA's huge new plant at Michoud Arsenal, 15 miles east of New Orleans.

The fabrication plant is currently being rehabilitated for *Saturn* production. NASA is evaluating proposals from some 35 companies to select a contractor to maintain and service the plant.

The first *Saturn S-I* unit turned out by Chrysler will be shipped to Cape Canaveral in early 1964. After maximum production is reached, one unit per month will be produced.

The space agency said that some Chrysler personnel would be assigned to the Michoud plant in the next two months. By mid-1962, some 180 people would be employed at the plant under the contract; peak employment of about 2400 would be reached during the first half of 1963.

## Firing from Silo Expedites Final Phase of Minuteman Tests



SUCCESSFUL first launching of a *Minuteman* ICBM from an underground silo this last week opened the way for a planned acceleration of the last stages of the missile's test program.

The Air Force still feels that it has a good chance of meeting its schedule of having the first operational *Minuteman* deployed on Montana prairie by mid-1962.

The first 50-missile squadron is expected to be deployed at Malmstrom AFB, Mont., by the end of 1962. A total of 12 squadrons—600 missiles—are expected to be deployed by early 1964.

The successful launching on Nov. 17 was the fifth in the *Minuteman* test series at Cape Canaveral. The Air Force box score to date: Three successes, on partial, two failures.

A geyser of smoke shot with flame poured from the silo in the first second after the missile ignited below the surface of the ground. Then the 58-ft solid-fueled ICBM roared skyward through the smoke and plummeted some 3000 miles down the Atlantic Missile Range. The missile when operational will have a range of 5500 nautical miles.

Before launching, the *Minuteman* was suspended in the 90-ft.-deep silo on a metal ring hung from the walls by metal straps. This arrangement will better enable the missile to withstand a near miss in a nuclear attack.

The launching was the second attempt at firing an untethered missile inside a silo. The first attempt last August ended when the second stage of the missile ignited prematurely seconds after the missile cleared the top of the silo.



## Soviets Claim 100-Megaton Warheads—Hint at Stockpile

Russia continued to rattle its rockets this week with the boast that Soviet missiles are armed with 100-megaton warheads.

It was the first time that Russia had claimed to have packaged its nuclear superbombs in operational warheads.

Moreover, the Russians hinted broadly that they have a sizable stockpile of the big weapons.

Meantime, a series of other East-West military developments and disclosures took place:

—The British Institute for Strategic Studies said sharply revised intelligence estimates give the United States an edge over the Soviet Union in land-based ICBM's as of early next year.

—Secretary of State Dean Rusk expressed some doubt as to the wisdom of equipping NATO nations with nuclear-tipped missiles at an early date.

—Russia disclosed the unification of Soviet missile and artillery forces under Chief Artillery Marshal Sergei Varentsov. Until recently, Marshal Kirill S. Moskalenko headed a special rocket command. One report said Moskalenko has been given a lesser post in the unified command.

The new boasts of Soviet missile might came in a number of statements published in celebration of Artillery Day.

Col. Gen. V. F. Tolubko scoffed at recent U.S. reports that Russia has only about 50 operational ICBM's. He called such reports "vain self-delusion."

In another article, Col. Gen. P. N. Kuleshov said the Russians "have successfully solved the problems of destroying various rockets in flight."

However, Kuleshov did not say whether Russia had developed a workable antimissile anti-ICBM system or he merely meant that a Soviet tactical missile is capable of intercepting another tactical missile.

The U.S. Army has already demonstrated several times the capability of various tactical missiles to intercept other tactical missiles. The technical problems involved in ICBM interception are far more difficult.

The Institute for Strategic Studies said a number of reasons have pre-

vented the Russians from deploying a much larger number of ICBM's by now as they originally were expected to do.

One of these is the vulnerability of the big Soviet *T-3's* and the problems associated with base-building. Another complementary reason is that Russia has under development a smaller, better and more easily concealed ICBM powered by a storable liquid propellant.

## Shots of the Week

Failures in the Nov. 18 launches of a *Ranger II* spacecraft and a *BIOS* space probe marred an otherwise successful week for U.S. rocketmen.

The *Ranger* spacecraft burned up in the earth's atmosphere after it failed to achieve its planned deep space trajectory. The *BIOS* capsule was lost when it landed far off its planned impact point in the Pacific Ocean.

The Air Force, however, successfully fired a *Minuteman* intercontinental missile from an underground launching tube (see opposite page) Nov. 17.

The Army sent two *Nike-Zeus* antimissile missiles on successful long range tests Nov. 17 and Nov. 21. The launches from the Pacific Missile Range involved the first two stages of the 48-ft., three-stage rocket. For the first time, the missile used a Thiokol second stage.

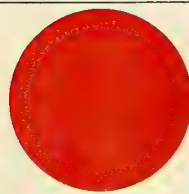
The Army also chalked up three other successes including: — Two launches of *Nike-Zeus* from the White Sands Missile Range. In the first test, the missile radar tracked a special test target and the ground electronics of the missile defense system successfully controlled a *Zeus* missile in flight. In the second, the missile was fired from an operational-type underground silo, then maneuvered in flight in response to control commands from its ground guidance center.

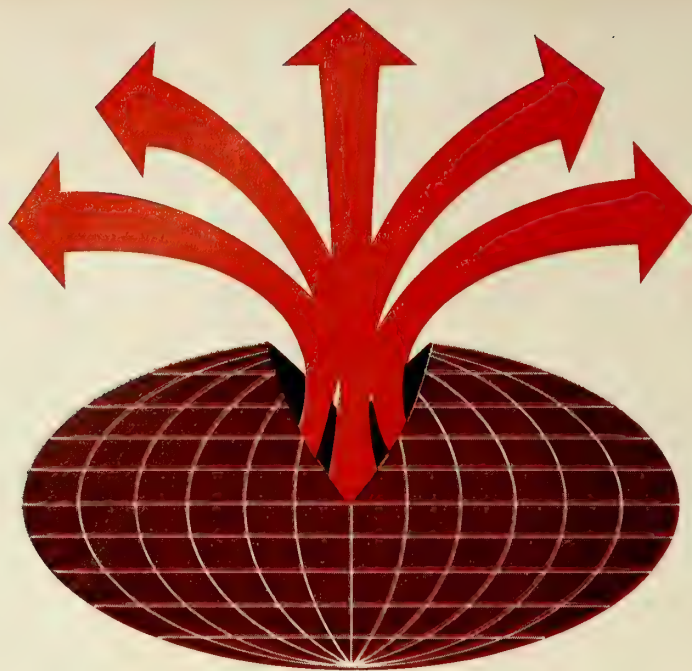
A U.S. Army *Pershing* missile was also successfully launched from Cape Canaveral.

The *Ranger* shot was beset with the same problem which hit *Ranger I*. The *Agena B* second stage again failed to refire, thus failing to send the spacecraft into a deep space trajectory planned as planned.

The spacecraft separated from the *Agena* and burned up in the earth's atmosphere following its sixth orbit. Officials said the failure might delay the launch of *Ranger III*, which is designed to rough-land on the moon. That shot had been scheduled for early 1962.

The *BIOS II* capsule—designed to determine the effects of the Van Allen radiation belts on living matter—was launched successfully into the Pacific Missile Range. The 85-lb. capsule parachuted into the sea far off course and was lost—as was *BIOS I* on Nov. 15.





## **EARTH SCIENCES AT DRESSER ELECTRONICS, NATURALLY!**

Since 1945 Dresser Electronics has been solving instrumentation problems associated with earth probes—first to find oil traps for petroleum geophysicists, now also to provide immediate answers to vital defense and security problems. A sample of present contracts—

*for:* **U.S. GEOLOGICAL SURVEY** (Major Crustal Studies Project)—Long-Range Recording Systems for VELA UNIFORM program.

**DEPT. OF DEFENSE** (Civil Defense)—an Automatic Radiation Monitoring System.

**USAF (ARPA)**—development and prototype of Unmanned Seismic Station.

**US ARMY** (Signal Supply Agency)—instruments and field studies relevant to seismic techniques for Missile Impact Location.

**USAF (Systems Command/Hanscom Field)**—development of VLF Electronic Seismometer with possible lunar probe application.

Dresser/SIE systems engineering is also at work in other projects throughout military, industrial and defense areas.

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## TRAAC Opens Doors

The orbiting of the Navy's *TRAAC* appears to have opened the way for improvement of the nation's surveillance and early warning satellites.

The *TRAAC* satellite—launched into orbit on *Transit IV-B* on Nov. 15—employs the earth's gravitational field for stabilization.

Though the announced application of this new probe was for the Navy's *Transit* navigational satellite program, a more important application is evident. The satellite could become the forerunner for improved stabilization techniques for many of this country's observation-type satellites, including *Tiros*, *Samos*, and *Midas*.

The Navy's proposed *Yo-Yo* reconnaissance satelloid program might also benefit.

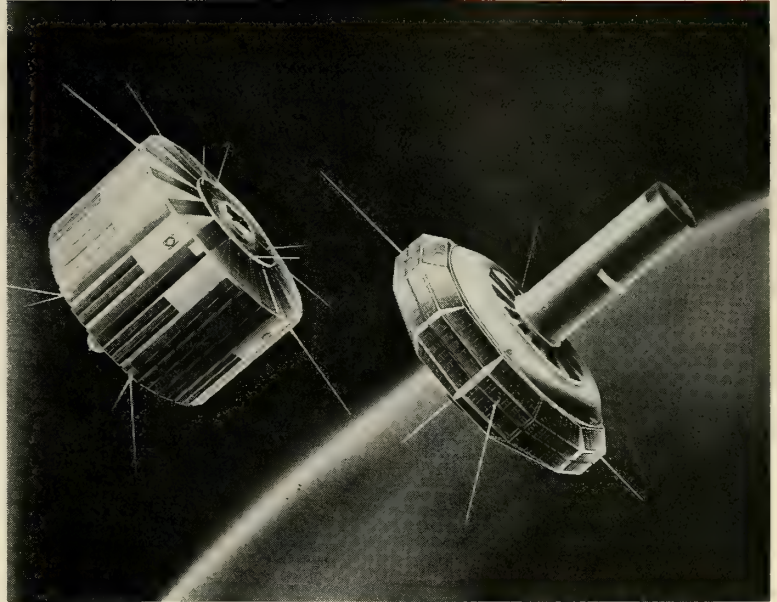
*TRAAC*, which stands for Transit Research and Attitude Control, was carried into orbit by *Transit IV-B* piggyback fashion. The major advantages of an earth-oriented vehicle for the *Transit* series involve improved transmitted signal reception and reduced power requirements.

Gravitational stabilization in the new system is maintained through purely passive means. This cuts weight requirements considerably over methods employing mechanical sensors and scanners.

The satellite is a door-knob-shaped affair which attains initial north/south stabilization through magnetic devices. Navy and APL scientists figure this initial stabilization takes about eight days.

At this point, a ground signal triggers a device in the satellite which releases a weight and rod arrangement from within the boom housing on the satellite. The shift in weight and mass distribution creates a dumb-bell shape for *TRAAC*, with the heavier end moving into a slightly slower orbit and closer to the earth. This, in essence, is the concept which keeps the same surface of the moon facing us. A lightweight spring is attached between both ends of the satellite for damping purposes.

Instrumentation for this gravity-gradient stabilization experiment includes solar and magnetic attitude detectors and spin rate detectors. These



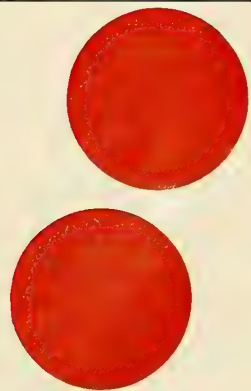
SEPARATION of Navy's *Transit* satellite (left) from piggyback *TRAAC* satellite took place at 500 mi. altitude Nov. 15 as shown in this artist's conception.

devices determine satellite attitude with respect to the sun, the earth's magnetic field, and the earth's gravitational field. Telemetry equipment is also aboard.

In addition to its primary mission, *TRAAC* is supplying data on particle detection experiments of the inner Van Allen radiation belt.

These experiments include probes to study the number density of protons, search for trapped particles heavier than protons, and investigate the cosmic-ray neutron albedo theory of the belt's origin.

Success of the experiment was in doubt last week due to a malfunction in the command-receiver system.



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## Tiros II One Year Old

NASA's *Tiros II* meteorological satellite passed a new milestone last week with the completion of its 5354th orbit, ending one year of successful operation.

The space agency said that the satellite has now been in orbit a total of 8760 hours—during which it has transmitted more than 35,000 photographs of the earth's cloud cover and billions of bits of infrared data for measuring the earth's heat balance.

## NASA Recruiting Drive

NASA has announced that its personnel recruiting teams will visit nine U.S. cities in late November and December.

The space agency said that the teams—attempting to fill 2000 scientific and engineering positions—will spend about three days in each of the cities in the eastern and western sections of the nation.

The western schedule includes Los Angeles, Nov. 27; San Diego, Dec. 1; San Francisco, Dec. 5; and Seattle, Dec. 9.

The eastern team will visit Cincinnati, Nov. 27; Pittsburgh, Dec. 1; Philadelphia, Dec. 7; Washington, Dec. 12; and Baltimore, December 15.

## Douglas Plans Expansion

The Missile and Space Systems Division of Douglas Aircraft Co. is studying plans for plant and research expansion which may total \$50 million over the next 10 years.

Charles R. Able, division vice president and general manager, said that the plans cover requirements for engineering, administrative, test and laboratory, basic research, and manufacturing facilities through 1971.

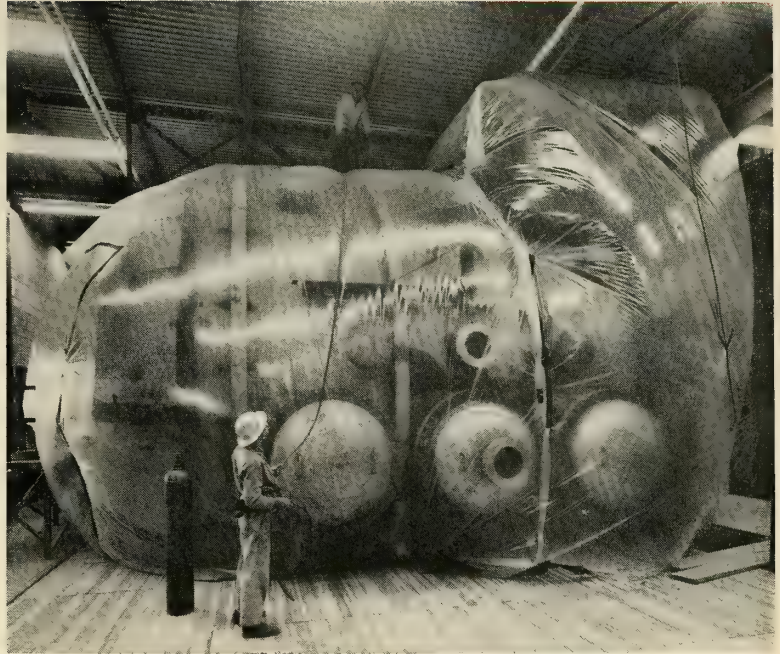
Construction of a \$3-million space chamber will begin in the near future.

Able estimated that manpower needs of the Division—located in Santa Monica, Calif.—will grow from the present 17,000 persons to 25,000 by 1971.

## Radioisotopic Capsule Tests

Effects of extremely high temperatures on radioisotopic fuel capsules

missiles and rockets, November 27, 1961



## Plastic-Wrapped Space Simulator

*BENDIX CORP'S environmental chamber, seen here undergoing final checkout, will be used to test full-sized satellites and space capsules. The 20 by 27 ft. unit is part of a new Bendix \$10 million space lab at Ann Arbor, Mich.*

designed to provide power for space vehicles will be tested next month by the Air Force Special Weapons Center.

Four tests, with General Dyna-

mics/Astronautics participating, will be held at the Atomic Energy Commission's Nevada Test Site.

They will provide data on the capability of radioisotopic fuel cap-



sules to remain intact when exposed to fire, and will permit study of the behavior of nuclear material which might be released into the atmosphere in the event a capsule melts.

### Limited Nike-Zeus Production Considered by Administration

The Kennedy Administration is considering a revised plan to include a limited production program for Nike-Zeus in the FY '63 defense budget.

The program would enable the Army to begin production work on the big Western Electric antimissile missile next summer if it is proved out in the coming final tests earlier in the year.

Some sources report that Defense Secretary Robert S. McNamara has already approved inclusion of the program in the budget and that only White House approval is now needed.

The program would enable the Army to begin deploying about 12 batteries of Zeus missiles toward the end of 1965. The batteries would be located around the country to defend

a number of key metropolitan areas. Full Zeus batteries are expected to have 20 to 30 missiles.

The initial outlay for production in the FY '63 budget is expected to be about \$150 million to \$200 million. The budget also will include about \$200 million for continued R&D. Total cost of the limited production program would run well over \$1 billion. Total cost of the full program previously proposed by the Army would be about \$8 billion.

The limited program—an expansion of the one proposed last year by the Army—would be designed so that it could be greatly stepped up. The Administration, by waiting to put the money in the FY '63 budget, also would leave itself the option to kill production before it even started.

### High-Temperature Resonators By Electrolysis of Quartz

Treated quartz resonators for use in high-temperature environments are now possible through a Bell Telephone Lab development in quartz electrolysis. The process sweeps out

impurities and the quartz retains its ability to vibrate with little energy dissipation even when used at 550°C. Depending on the angle of cut, processed quartz exhibits turn-over points at temperature from 300° to 535°C. At these high temperatures there is a constant annealing out of ionization effects which makes the crystals ideal for applications in the Van Allen Belts.

### Nuclear Work Shifts to Lewis

NASA is consolidating its nuclear electric propulsion program at the Lewis Research Center in Cleveland.

As a result, current research work in this area at the Marshall Space Flight Center will be transferred to Lewis.

The transfer, however, will not affect the RIFT program, which will flight-test nuclear rockets as upper stages of large chemical boosters.

That program will remain at Marshall under the direction of Dr. Ernst Stuhlinger, director of the Research Products Division.

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STAPLEX HI-VOLUME Air Samplers are used to gather the extremely variable statistics so necessary to efficiently evaluate and eliminate the pollutant factors in all air borne particulate matter.

Increased industrial production, fabrication of new metals such as beryllium, the presence of smog, radioactive fallout, the advent of the "White Room," government and city health agency regulations, insurance requirements—in all these areas and many more, STAPLEX HI-VOLUME Air Samplers are a must.

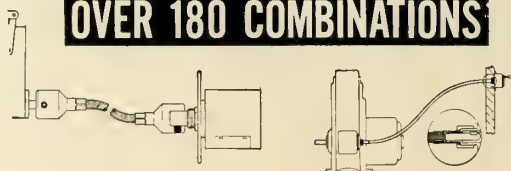
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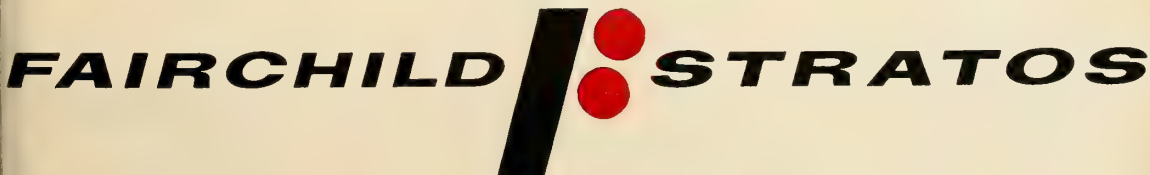


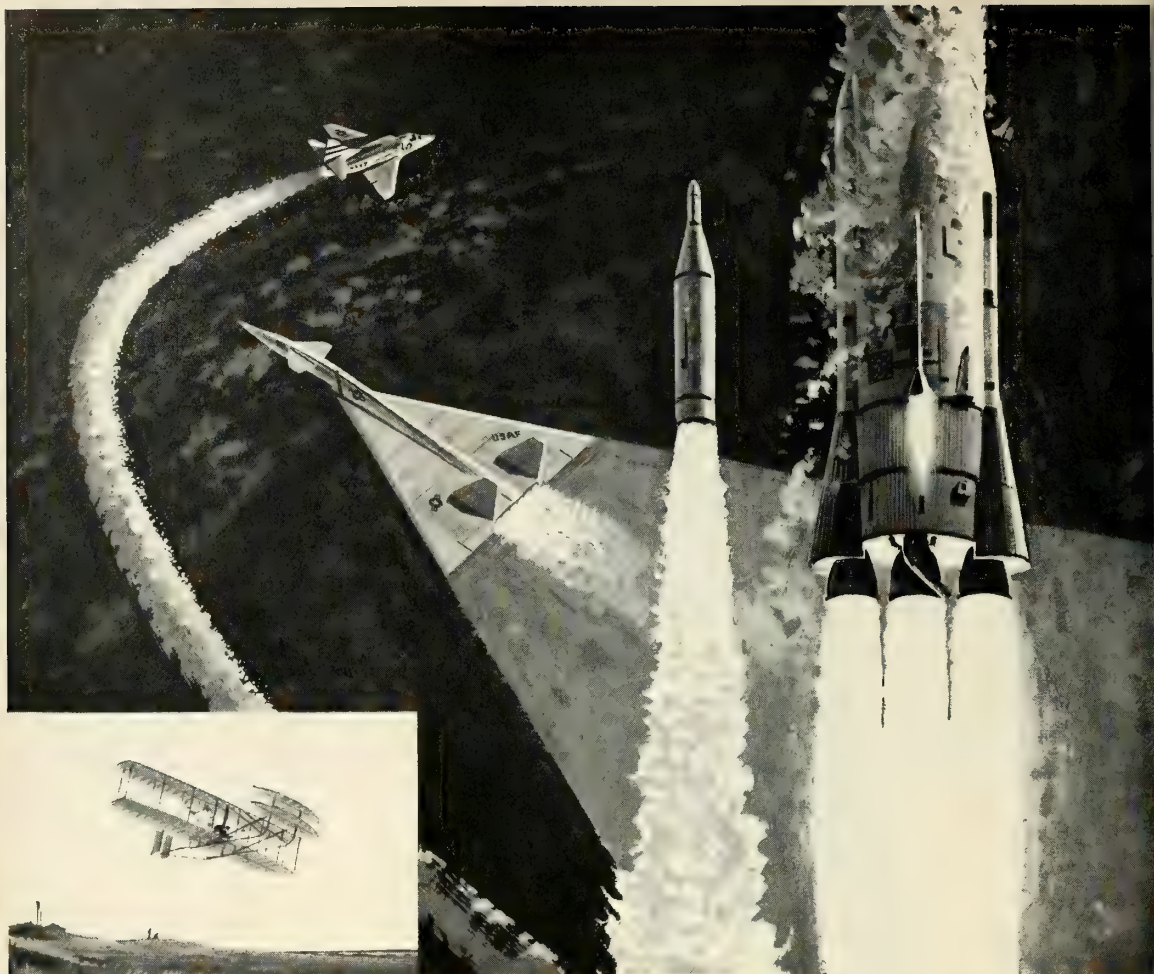




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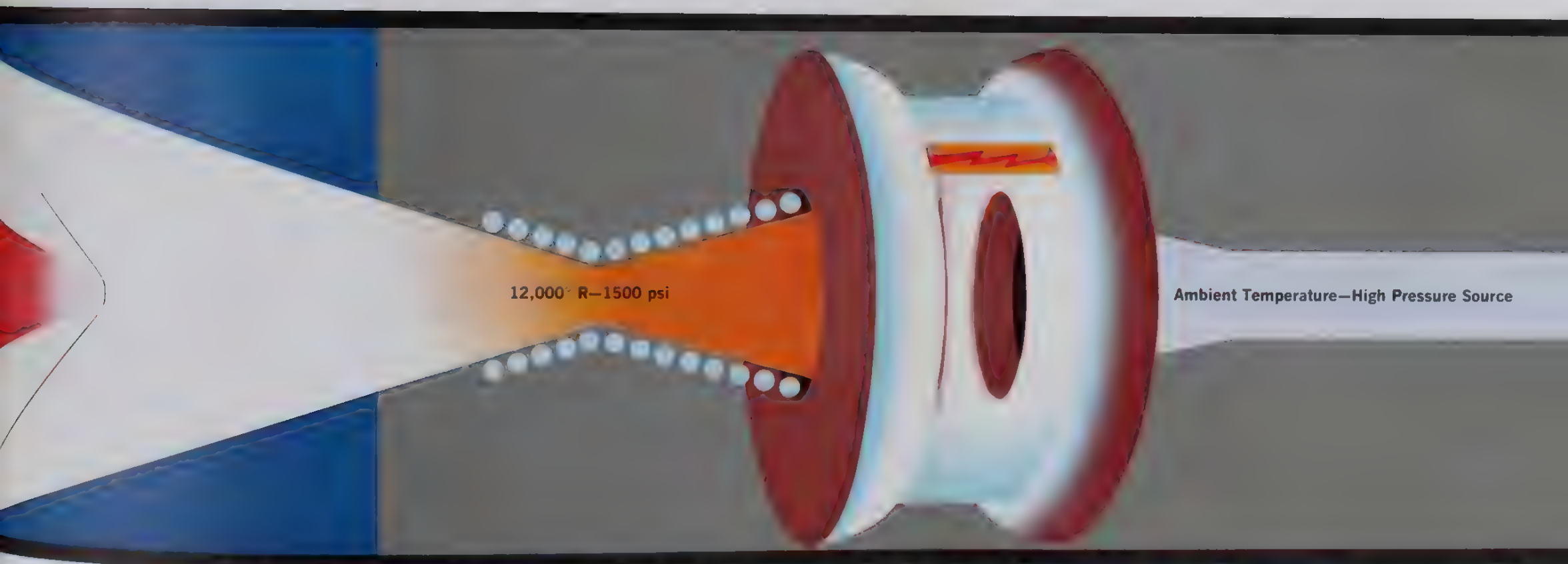
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To date, shock tubes and hotshots have provided only a brief instant of flight corridor exploration. The Westinghouse Arc Heater now provides accurate control of clean environment simulation over expanded ranges for as long as ten minutes.

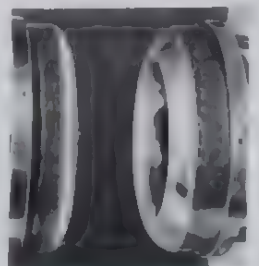
The usefulness of test facilities is increased several orders of magnitude due to the extremely low impurities level—0.2% from the Arc Heater! In addition, it can provide clean heat for catalytic cracking, metals refining, ionization and MHD acceleration.

Initial research, with total funding by Westinghouse for the Arc Heater, assures a completely engineered and tested device unequalled in its field. It is complemented by an expertly coordinated power supply made up of modular components permitting future expansion. An energy transfer of 50% in units rated ten megawatts develops a minimum enthalpy of 6,000 BTU/Lb. of air, a temperature of 12,500°F with relatively low

mass flow—all at 1500 psia pressure. An extension of the development program provides for pressures from 20 psia to 3,000 psia with increased efficiency. Built-in shielding eliminates any external magnetic effects.

You are invited to use the capabilities at Westinghouse to help solve your aerospace facility problems. Contact your local Westinghouse sales engineer, or write: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse.

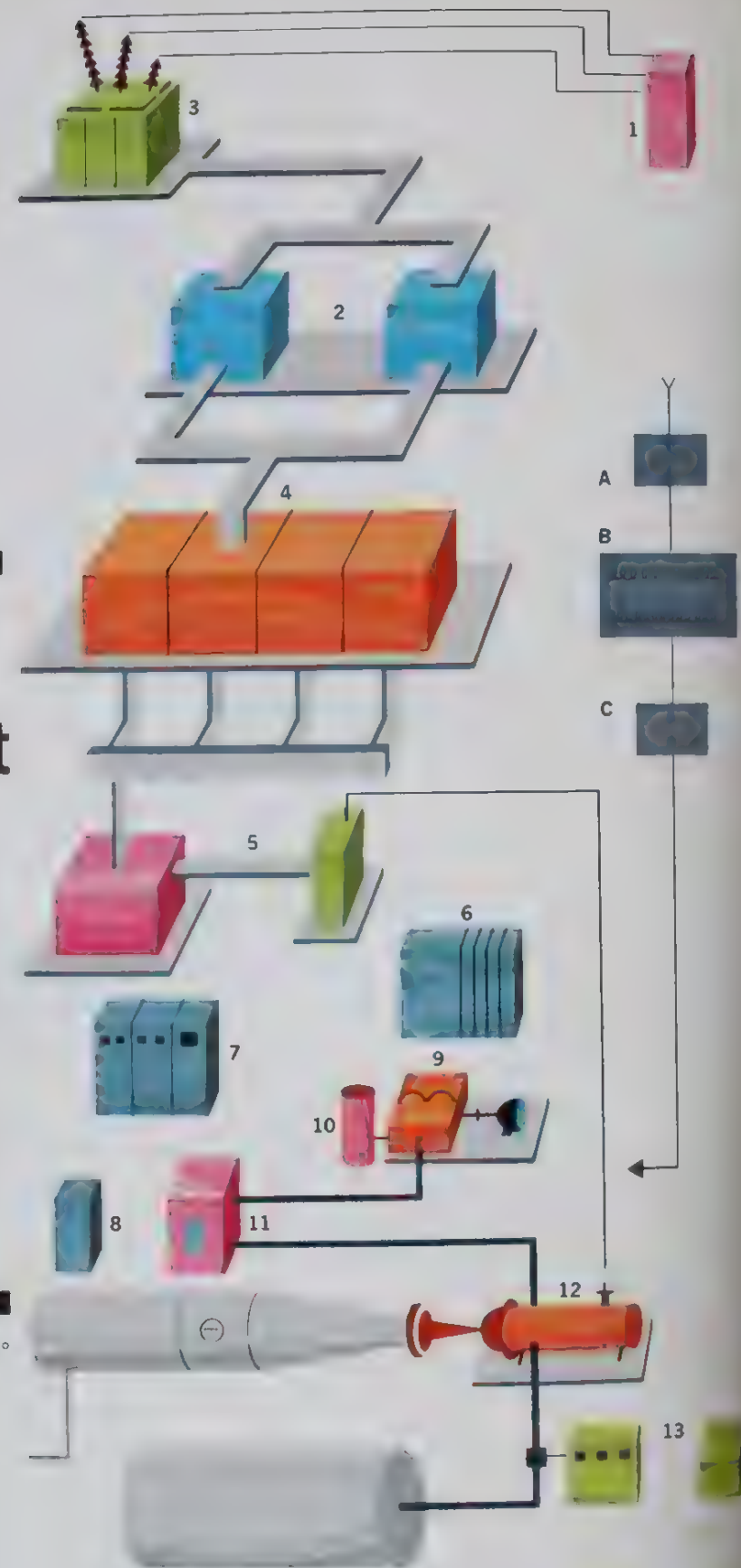
*These working electrodes, fabricated from a new Westinghouse developed alloy, have excellent electrical and thermal conductivity properties. The electrodes use oxygen-free copper, while retaining their inherent superior mechanical strength.*



For system data, please see back page.

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A typical DC system utilizes modular silicon rectifiers (4) fed from balanced power transformers (3) varied by the load tap-changer (2). Switching and isolation of the system is done with the metalclad breaker (1). Ballast (5), consisting of matched reactor and resistor stabilizes the arc. Safe, precise, accurate control stations (6) (7) (8) (13) provide automatic sequencing with manual over-ride. Trouble-free, long-life operation of the Arc Heater and nozzle (12) is insured by the closed-loop cooling system (9) (10) (11). Increased efficiency and lower initial cost for power is apparent when a three phase AC arrangement (A) (B) (C), is substituted for (1) (2) (3) (4) (5).

State-of-the-Art Report from Westinghouse:



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## Mobilizing for the Moon—NASA's Big Plan

AFTER MONTHS of deliberation the plan of attack is ready: How the National Aeronautics and Space Administration intends to mobilize the Missile/Space Industry for manned exploration of the moon. Here, in its premier annual NASA issue, M/R presents the first truly comprehensive report on how the mobilization plan is to be executed. Begin-

ning on page 46, you will find an industry guide to all the key programs and critical hurdles involved in the multibillion-dollar undertaking. Further on there are reports on contracting and each one of the 13 NASA installations across the nation—how they are organized and the important roles they will play in the total space program over the next eight years.

# The Moon: America's Most Difficult Endeavor



NASA Administrator Webb

**B**EFORE this decade is out, the United States plans to land a scientist-astronaut team on the moon.

The lunar landing, a national goal recommended by President Kennedy and endorsed by Congress this year, is the most difficult and dramatic of the missions assigned to the National Aeronautics and Space Administration. Some people believe it is the most ambitious endeavor in the history of mankind.

• **Other objectives**—NASA has accelerated its program to achieve other important national goals in space:

—Establishment of a global system of communication satellites, so that greatly expanded telephone, telegraph, data communication channels, and — eventually — ocean-spanning TV will be available to our country and the world.

—Creation of a worldwide operational network of weather satellites, to enable meteorologists to observe and predict the weather—and to make a start in the direction of controlling it.

—Broad-scale, rapid advancement of scientific knowledge of space, the moon and planets, the earth's atmosphere, and the fields and particles that surround it, as well as aerospace medicine to provide for the safety of the men who will travel through the solar system.

—Rapid improvement in space technology, including application of nuclear energy to propulsion and generation of electrical power.

—Prompt feedback of space technology into our economy, to make certain of maximum benefits to the American people through economic growth and industrial progress.

• **Motivation**—There are many practical, technological, and scientific reasons why the United States is exerting great efforts toward accomplishing the Nation's goals in space. Perhaps I need not list them for readers of *MISSILES AND ROCKETS*. Still, I believe that some of the basic considerations that motivated the Nation's decision bear restating.

First, by achieving a pre-eminent position in space, we insure that the over-all technology which the Russians derive from exploring the universe will not be used against us. If we should allow them to surpass us, they would use their superiority to apply heavy pressure on us and the other nations of the Free World.

Second, the stimulus and the knowledge that are developing as we carry forward our broad programs in space will return practical dividends in the form of new products and techniques of great value to industry, the professions, and everyday life.

Third, exploring space is of immense scientific importance. The moon, for example, may hold the answers to such questions as how the solar system was created, where life began, and how planets develop and change. It is, as always, impossible to predict what use will be made

of the scientific knowledge. But history has repeatedly shown that the results of investigations in basic science are used eventually for man's betterment.

• **National scope**—No single organization has all the resources and skills necessary for attaining our goals in space. The space program is, and must continue to be, national in scope. Therefore, NASA cooperates with, and depends on, many other Government agencies—the Department of Defense, the Atomic Energy Commission, the Weather Bureau, the Federal Communications Commission, the Federal Aviation Agency, the National Science Foundation, the National Academy of Sciences, and others.

To assure maximum progress, NASA utilizes industrial contractors to the greatest extent possible. Eighty cents of every dollar NASA spends goes for contracts with industry and private organizations, for materials, supplies, salaries, research, development, and for other services.

In order to supervise contractors' work effectively, we must understand and follow it in every phase from start to completion. This requires a competent NASA in-house staff. As the size of the task assigned to contractors grows, additional in-house staff will have to be added to efficiently manage the program.

• **Self-sacrifice**—Some of the Nation's best qualified men in aerospace science and technology, men who have made important contributions to the national position by their work in our universities and industry, have accepted leading roles with NASA. They bring into the effort the highest personal, professional, and managerial qualifications. These men, and many others associated with them, have demonstrated personal earning capacities far beyond what the Government is able to pay for their services.

It is fortunate for this Nation that men with such high qualifications and experience are willing to forego large earnings and normal personal and family life to supply the leadership needed in our national space effort.

• **Prompt decisions**—The past months have been a time of many decisions in the U.S. space program. I need not recount for the readers of *MISSILES AND ROCKETS* the actions by the President and Congress, the selection of sites for launching and testing large rockets and spacecraft that will be required, the enhancement of existing programs, the awarding of major contracts, and the reorganization of NASA that have taken place.

By making decisions promptly, we have been able to get moving at high speed toward the accomplishment of our national goals in space. We will continue to make prompt decisions.

*James E. Webb*





# Industry's Toughest Assignment: Make it Work

Deputy Administrator Dryden

**A** PROGRAM designed to land a man on the moon and bring him back safely in this decade is perhaps the most difficult single task that this nation has ever undertaken.

It will require personnel and facilities of not one, but several government agencies—including the Defense Department, the Atomic Energy Commission, the Department of Commerce and the National Aeronautics and Space Administration.

College and university laboratories will be called upon to support basic research activity and supply the country with increasing numbers of qualified scientists and engineers.

Industry will design and fabricate the boosters, space vehicles, launch facilities and worldwide tracking stations for the many different types of space missions. Industrial management and scientific teams will be asked to furnish the know-how that is required to solve the multitude of problems facing us in the space age.

- **Prime requirements**—The most immediate problem is the development of reliable launch vehicles and spacecraft capable of performing sustained manned space flight missions.

Beyond this a life support system to provide a suitable environment for periods of several weeks is required. Radiation shielding is needed to give sufficient protection during passage to and from the moon as well as on the lunar surface.

Another requirement is a navigation system which will give position fixes, and which will compute the amount and direction of thrust for course corrections when required. An attitude stabilization system to be used throughout the flight is also needed to permit orientation of the spacecraft for thrust control as well as for lunar landing and reentry through the atmosphere. And of course communications will be required for all phases of the flight.

- **Industry's duty**—In meeting the problems directly connected with the Nation's accelerated space program, industry must also assume special responsibilities. One of the most important is to strive for reliability of all parts of a complex system no matter how small or seemingly unimportant. Failure of one small part can mean complete failure of an important and costly mission. Another important industry responsibility is to work with universities in order to provide for the education of greatly increased numbers of scientists, engineers and technicians for roles in space exploration, and for other major technological developments of future importance to this country.

The space age challenge to industry, however, is not only to mobilize its forces for a direct attack on the problems involved in manned space flight, but to look for and

develop the new consumer goods and industrial processes that are certain to evolve from this program for the benefit of all mankind.

- **The bigger dividends**—History abounds with examples of the manner in which man's striving toward difficult technical goals has brought on vast, unforeseeable dividends.

Development of the automobile, for example, brought us the concept of simplification for the operator through complication of design, a concept now widely applied in the operation of a modern steel mill or oil refinery and in such modern consumer products as automatic washers and ovens, where automatic controls program the entire operation. The automobile is largely responsible for the development of alloy steels, new fuels, synthetic rubber, quick-drying finishes, and other new materials.

Similarly the air age brought about the use of aluminum for building lightweight structures, not only for airplanes but for trains, buses and ships. The nuclear age brought applications of isotopes in medicine and in the inspection of materials. Nuclear developments brought remote manipulators and sealed pumps for hazardous liquids and gases.

The forward movement of space technology, with its many ramifications in our industrial life, will stimulate our economy just as these other great technological developments have done in the past.

A multitude of space-related products have been developed in the United States. Miniature electronic parts devised to save weight in rockets and their payloads are now being used in tiny hearing aids, medical equipment, midget radios and portable TV sets, and in a host of other products.

Into other consumer goods are going new materials, alloys, plastics, fabrics, and compounds of many kinds originally created to do space jobs. In fact, the space program is drawing upon and stimulating virtually the entire industrial spectrum—electronics, metals, fuels, ceramics, machinery, instruments, and textiles.

There is great potential in communications satellites, meteorological satellites and navigation satellites, all under development.

While the technological developments offer the earliest contributions to the economic development, in the long run the contributions from the scientific knowledge obtained in the great unknown environment of interplanetary space may bring much greater returns, perhaps far beyond what man at this time could possibly envision.

*Hugh L. Dryden*

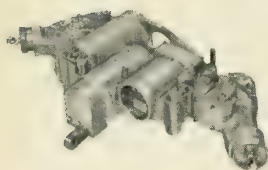
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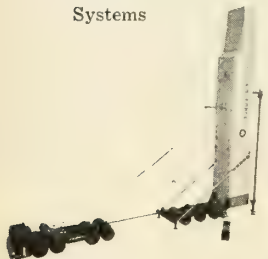
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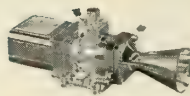


Miniature Hydraulic  
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Controllers—  
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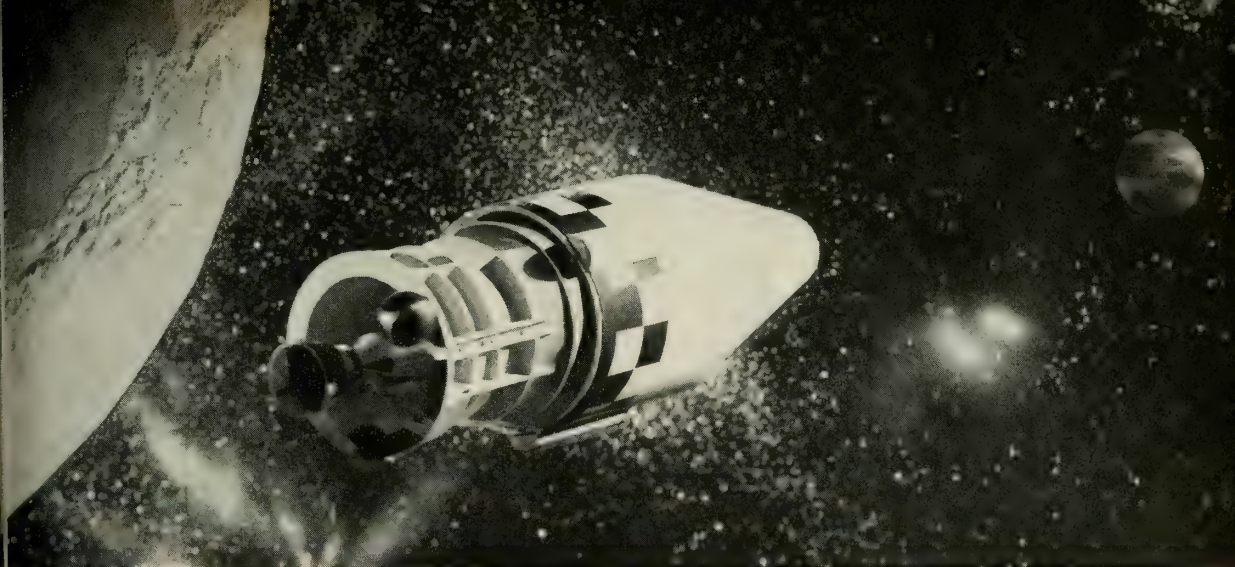
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A TYPE OF THE LOCKHEED AGENA SATELLITE IN ORBIT

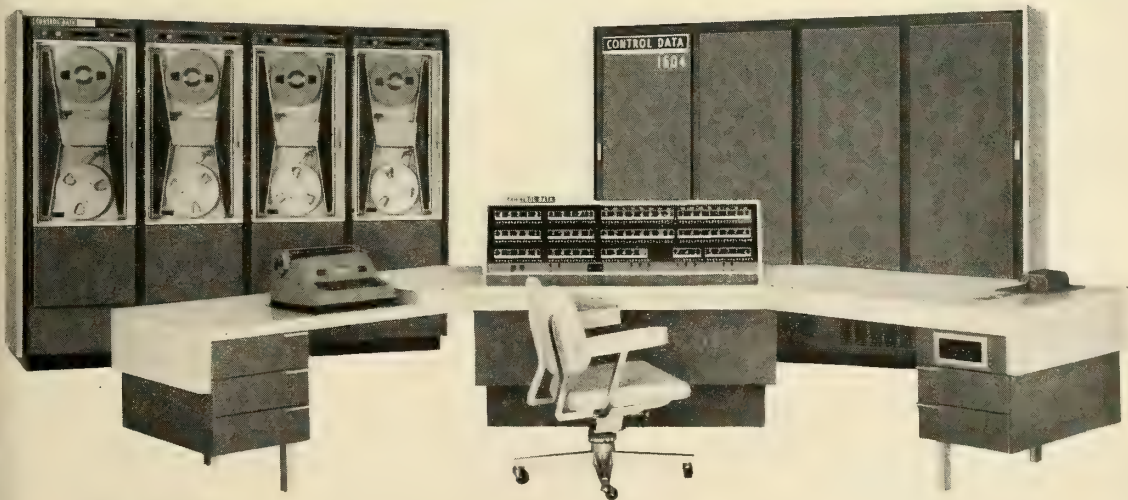
## CONTROL DATA 1604: KEY TO SATELLITE CONTROL

In the control, tracking, and orbital prediction of satellites, a precise balance between men and machines is of critical importance. During countdown, to the time the satellite climbs to escape velocity, enters, and then progresses in its orbital path, both the vehicle and tracking networks girdling the earth are under absolute control.

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"read" volumes of data picked off by far-flung radar stations. And from time to time, they also "predict" future orbital paths the vehicle may take. Finally, for thorough analysis of an entire mission, 1604's process the quantities of data collected.

Handling computer programs of 50,000 words, the speed necessary to operate in "real time," and the reliability to "stay on the air" over extended periods of time are but a few of the 1604 Computer capabilities essential in the control of a satellite and tracking network...capabilities being used today to aid man in his exploration of space.



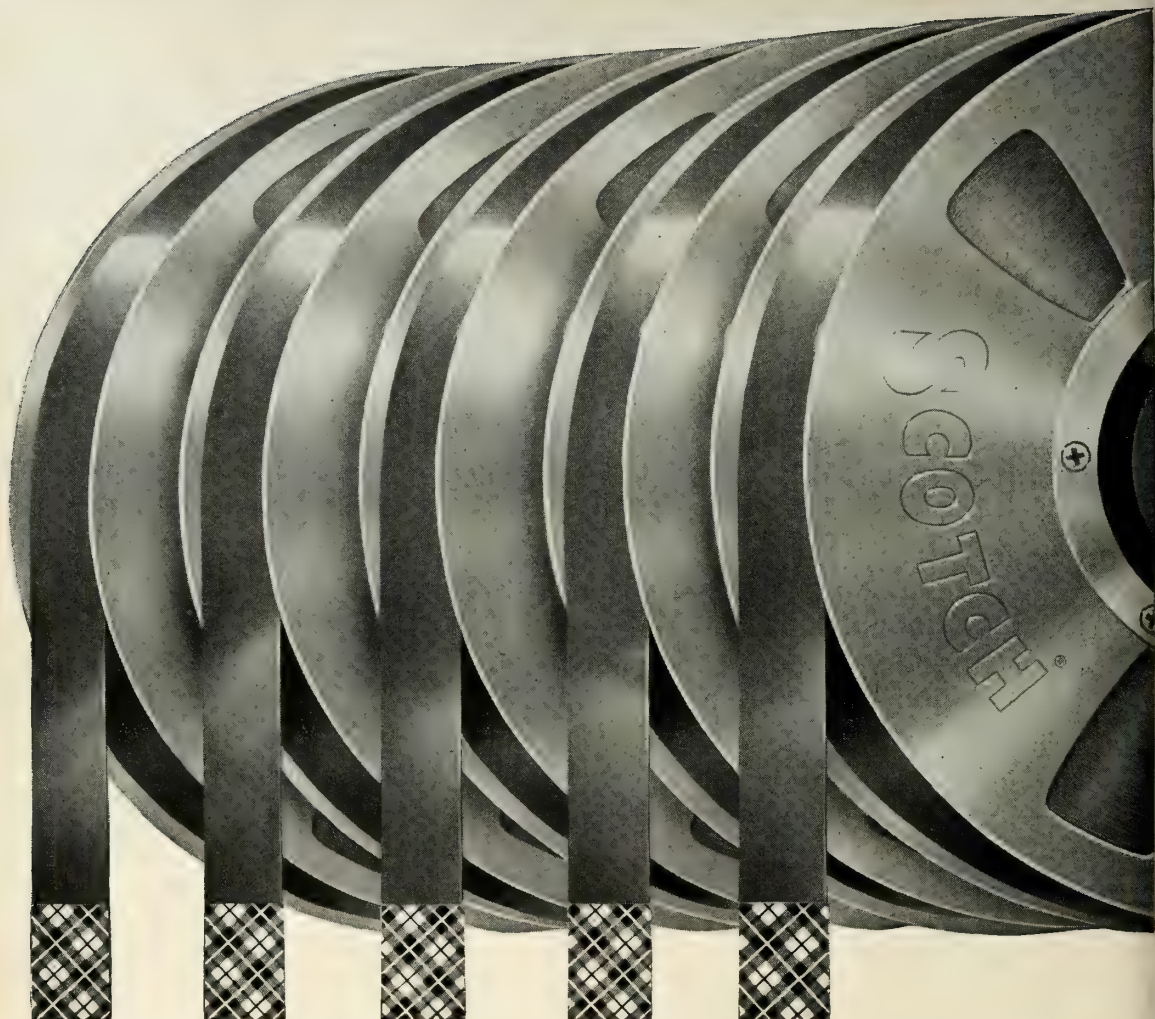
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## JOHNS-MANVILLE



# The \$50-Billion Space Push

*Some 70 percent of NASA's budget flooding into Apollo Manned Lunar Landing Program; agency fixes government-industry team and readies basic contracts*

BIG MONEY is about to flood into the NASA-led drive for the moon.

The basic contracts are nearly ready to be let for the *Apollo* Manned Lunar Landing Program—a rapidly escalating assault on space that is now expected to push NASA's total spending in this decade to more than \$50 billion.

For some six months the vastly accelerated U.S. drive to beat Russia in landing the first men on the moon has consisted primarily of study and planning. That period is ending.

The overall plan now calls for orbiting the first *Apollo* spacecraft around the earth about 1964 and landing the first Americans on the moon about 1967. The previously planned circumlunar flight before attempting a landing may be dropped. The framework of the government-industrial team for this staggering undertaking is all but fixed.

Within the next four to eight weeks NASA will award a tattoo of key prime contracts that eventually will run into billions of dollars.

In doing this, NASA will pick the leaders of the *Apollo* industry team. And, for the first time, it will have put the entire program in motion.

## About This Special Issue . . .

*This issue, devoted entirely to the work and plans of the National Aeronautics and Space Administration, was researched and written by a Missiles and Rockets editorial task force which visited every NASA installation across the nation. Headed up by NASA Editor Hal Taylor, the task force consisted of Senior Editors James Baar and Charles D. LaFond, Engineering Editor William Beller, Materials Editor John F. Judge, GSE Editor James Trainor, Space Medicine Editor Heather M. David and, on the West Coast, M/R Editors Richard van Osten and Bill Wilks.*

• **Scramble for top**—There are a total of 17 missile/space companies fighting for top position on one or more of the major contracts.

Two—General Dynamics/Astronautics and Martin—are seeking the prime contract in both propulsion and spacecraft systems. Three others—Lockheed, Ling-Temco-Vought and Space Technology Laboratories—are bidding for one part of the program as primes, and as associate primes for another.

The three key contracts are:

—Production of the *S-1* booster—Seven firms are competing for the contract on the clustered 1.5-million-lb.-thrust first stage of the *Saturn C-1*. The seven are Boeing, Chrysler, Ling-Temco-Vought, Ford Aeronutronic, Avco, Northrop and Lockheed. The contract is expected to be let imminently.

—Production of the *S-1B* booster—Five firms are competing for the contract on the expected cluster of four 1.5-million-lb.-thrust F-1 engines for the *Saturn C-4* booster. The five are Boeing, Martin, Aerojet-General, Space Technology Laboratories, and General Dynamics/Astronautics. The contract is expected to be let early next year.

—Development of the *Apollo* spacecraft—Five firms are competing. They are Martin, General Dynamics/Astronautics, GE, McDonnell and North American Aviation. GE has a bidding team including Space Technology Laboratories, Douglas and Grumman. McDonnell has a team including Ling-Temco-Vought, Lockheed and Hughes. The contract is expected before Jan. 1.

Meantime, the first contracts in the lunar facilities construction program at Cape Canaveral are also expected to be let early next year. Latest estimates on the total cost of the huge new spaceport are running to more than \$1 billion.

NASA officials have already decided that the R&D program for the *Apollo* spacecraft will be handled by a prime contractor and a number of associate primes. However, a decision on the organization of the industry team for the overall *Saturn* vehicles is still pending.



NASA is considering three possible ways to put together the *Saturns*. The prime contractor for the booster could be made the overall prime as well. NASA's Marshall Space Flight Center, which is in charge of the *Apollo* superbooster program, could do the integration. Or Marshall could do it with technical assistance from a contractor.

The establishing and refining of plans for the *Apollo* Program have been accompanied by refining of cost estimates. The trend is upward.

Originally, some official estimates put the total cost at about \$20 billion. Some estimates now put the cost at about \$35 billion or more depending on what is included.

Like the estimates of all big R&D programs, the figures for *Apollo* and other NASA programs become increasingly tentative as they stretch toward the end of the decade. As a guide, however, \$35 billion plus may be considered reasonable—and probably low.

The hardest figures are the expected budget requests for the next two fiscal years. For FY '63, NASA is seeking a total budget of about \$3.7 billion—more than double the \$1.7 billion that Congress authorized for the current fiscal year. NASA also is seeking a supplemental FY '62 appropriation, probably some \$112 million to make up the amount cut by Congress last summer.

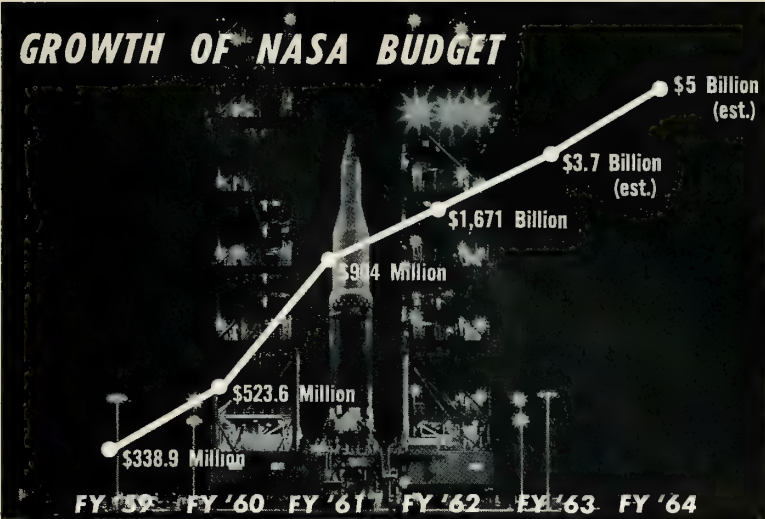
For FY '64, NASA is expected to seek about \$5 billion to \$5.5 billion. That is nearly half of the current budget of the U.S. Army; more than the annual outlay for the Strategic Air Command.

This FY '64 figure of about \$5.5 billion is officially looked upon as an annual "plateau figure" for the rest of the decade. By adding normal price increases and the usual unforeseen costs, the "plateau figure" will push total NASA spending for the 1960's to about \$50 billion.

One of the important variables in reaching this estimate is the cost of manned spacecraft programs beyond the first three-man missions to the moon.

NASA Administrator James Webb has already spoken of begin-

NASA's R&D (right) falls into three groups: top (blue), Apollo Manned Lunar Landing; (bottom gray) applied & scientific; (middle white) work contributing to Apollo and other programs.



| Program                         | FY '60  | FY '61           | FY '62    |
|---------------------------------|---------|------------------|-----------|
| (Authorizations in Millions)    |         |                  |           |
| Apollo                          | \$ .1   | \$ 1             | \$ 160    |
| Mercury                         | 84.3    | 109.5            | 74.2      |
| Launch Vehicle Technology       | —       | 9.1              | 27        |
| Launch Operations Development   | .1      |                  | 1.5       |
| Spacecraft Technology           | 4       | 7.9              | 10.3      |
| Solid Propulsion                | 1.7     | 1.3              | 3.1       |
| Liquid Propulsion               | 27.2    | 57               | 93        |
| Nuclear Systems                 | 5.6     | 12.6             | 36        |
| Space Power Technology          | 3.5     | 4.2              | 5.5       |
| Saturn                          | 9.4     | 118              | 224.1     |
| Tracking & Data Acquisition     | 16.1    | 31.6             | 38.6      |
| Nova                            | —       | —                | 48.5      |
| Life Sciences                   | —       | 5                | 20.6      |
| Lunar and Planetary Exploration | 49.9    | 82.5             | 159.9     |
| Centaur                         | 9.4     | 118              | 224.2     |
| NASA Plant Support              | 27.7    | 48.2             | 89.1      |
| Research Grants & Contracts     | 4.8     | 5                | 7.6       |
| Scientific Satellites           | 20.2    | 37.9             | 72.7      |
| Electric Propulsion             | 1.3     | 3.3              | 6.8       |
| Meteorological Satellites       | 7.9     | 18.1             | 50.2      |
| Communications Satellites       | 3       | 29.5             | 94.6      |
| Sounding Rockets                | 9.7     | 8.2              | 9         |
| Scout                           | 3       | 3.9              | 3.7       |
| Delta                           | 12.5    | 11.8             | 2.9       |
| Vega                            | 4       | (Program Killed) |           |
| Total R&D                       | 333.1   | 668.5            | 1,295.5   |
| Total Salaries and Expenses     | 89.4    | 176.9            | 230.1     |
| Total Construction              | 99.6    | 124.7            | 262       |
| GRAND TOTAL                     | \$523.5 | \$964            | \$1,784.3 |

ning work in the mid-60's on a 10-man or 12-man space station for use in "further lunar and interplanetary exploration." And funding will be included in the budgets for FY '63 and FY '64 for planning and early design work on advanced spacecraft of various types.

A second important variable is the role of the Air Force in space. Sizable increases in military space programs over the next few years could result in the revision of NASA long-range plans with a complementary revision in the agency's budget.

However, this would not necessarily result in a budget reduction. It would depend on whether NASA or the Defense Department undertook the funding of future development programs needed for both space exploration

and space weapon systems.

The Air Force also has advanced the argument that its facilities and trained personnel should be brought into the Manned Lunar Landing Program as much as possible. Conceivably, use of these resources could result in some downward revisions of NASA spending. However there is considerable disagreement as to the availability and applicability of Air Force facilities and personnel. At least one congressional investigation in this area is planned for early next year.

A principal target for congressional inquiries in this line is NASA's plan to establish a new multimillion dollar headquarters for its Space Task Group at Houston, Texas. Both the need for all or part of the planned Houston facilities and the site are being questioned.

NASA officials contend that the Space Task Group, which is in charge of development of the *Apollo* spacecraft has needed expanded facilities for some time. They contend that, among other reasons, Houston was chosen as part of a deliberate program to broaden the nation's technological base.

A third important variable in the size of NASA's future budgets is political support in the Administration and Congress. At present, vast increases in spending on space programs are enjoying wide political backing. The cut-off within the national budget has yet to be reached.

• **Strength in union**—An important factor in maintaining political support is certain to be the continued invoking of the argument that *Apollo* is necessary for the future security of the nation. The NASA and DOE space budgets along with the smaller space budgets of other agencies are expected to be lumped together in a special section of the National Budget that will be sent to Congress in January. This technique could have its political advantages as well as drawbacks.

Disentangling NASA budgets to determine how much is being spent on the *Apollo* Program and how much on other programs is difficult because of considerable overlapping in a number of areas.

Such unmanned spacecraft as lunar-exploring *Prospectors* and *Surveyors* will greatly expand mankind's knowledge of the moon and therefore have a substantial scientific value in their own right. But they also will greatly aid manned exploration of the moon at a later date.

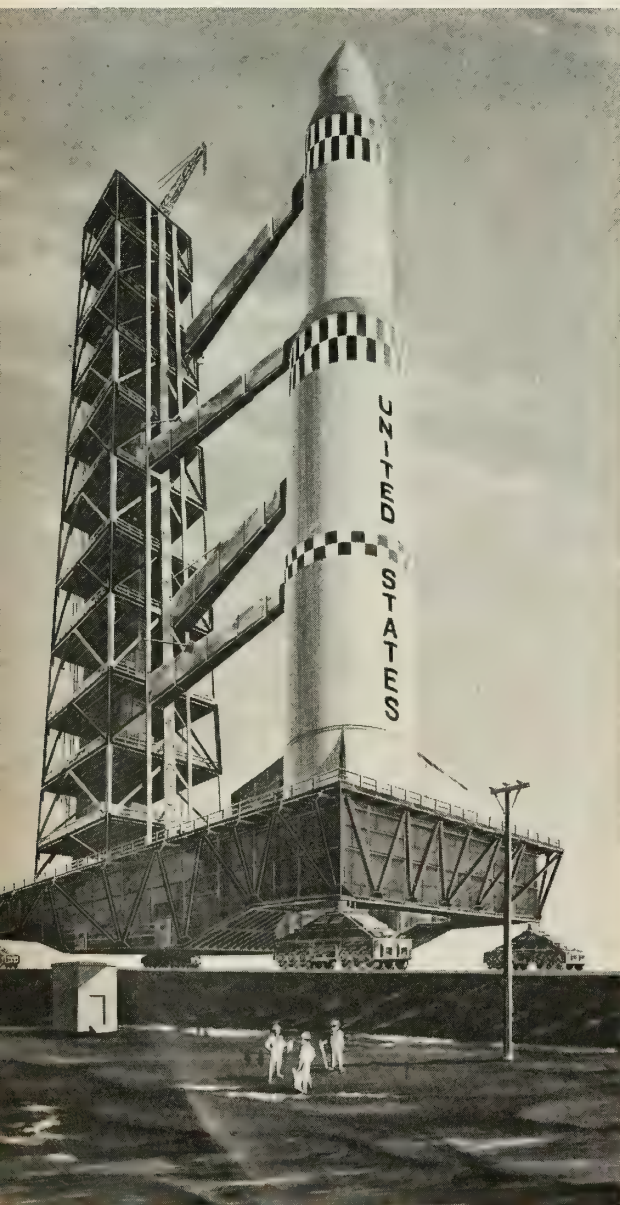
Additions to the NASA tracking network are needed for unmanned exploration of space. However, the bulk of the additions would be needed for manned spaceflight and manned lunar landings even if there were no other programs.

Other gray areas include the programs for scientific satellites, the *Centaur* upper-stage and basic research performed under grants and contracts. And, finally, money for support of the NASA plant, salaries and expenses and construction of facilities is often difficult to attribute to one program or another.

In NASA itself, budget officials attribute roughly 60 percent of the agency's current \$1.7-billion budget to the *Apollo* Lunar Landing Program and 40 percent to all other programs.

Moreover, they expect this difference to increase over the next few years until 65 percent or even 70 percent of the total NASA budget will go to the *Apollo*.

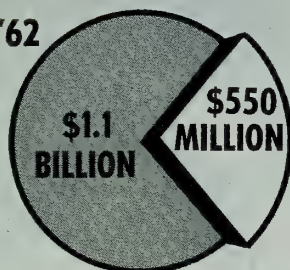
Some officials put the *Apollo* percentage still higher



NASA ARTIST'S CONCEPT of rail-transportable launch for Saturn C-4. Alternative would be barge launching.



FY '62



\$1.7 BILLION

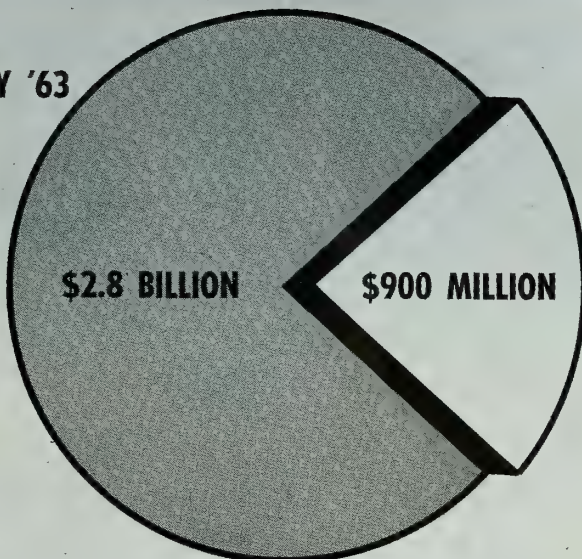


MANNED LUNAR LANDING



OTHER PROGRAMS

FY '63



\$3.7 BILLION (EST.)

### How NASA Is Slicing Its Budget Pies

including such programs as the development of nuclear-powered rockets. These estimates today put the budget slice for *Apollo* at about 70 percent or more and forecast a considerable increase within the next two to three years.

On the basis of these various percentages, the *Apollo* program and follow-on programs will spend between \$35 billion and \$40 billion of the total NASA budget in the 1960's.

This spending on *Apollo* can be roughly broken down further into three major areas. Officials estimate that about 40 percent—some \$14 billion to \$16 billion—will be spent on the *Apollo* spacecraft. And the remaining 20 percent—\$7 billion to \$8 billion—will be spent on *Apollo* launching complexes and technical facilities.

The clear overshadowing of all other NASA programs by *Apollo* has called into question among a number of congressmen and in industry the workability of NASA's recently restyled organization.

Worried critics argue that the agency's organization appears to be unrealistic in that it gives equal position along with the *Apollo* Program to the three offices under which all other programs are grouped.

They contend that many parts of the overall *Apollo* program are scattered in these other offices. Therefore, they contend the entire *Apollo* Program is not within the administrative control of its appointed chief, Director D. Brainerd Holmes of the Manned Space Flight Office.

Instead, they argue, the only official holding all of the *Apollo* strings along with the strings to all of NASA's other programs is Associate Administrator Robert C. Seamans.

NASA officials counter that Holmes is the boss of the *Apollo* Program, that he is directly responsible for the de-

velopment of the propulsion systems and spacecraft and their overall integration and that he has all of the authority that he needs to do the job.

As Seamans, himself, put it recently:

"We have given the Manned Space Flight Office the tools to do the job within reason. When you come to gathering data, they can receive from the Space Sciences Office whatever is needed. If a nuclear-powered rocket should be found necessary in a few years, we will transfer the rocket to them."

• **Proof to come**—Any judgment as to criticisms of the NASA reorganization will have to await future events. NASA is convinced that the future will prove that its reorganization was a good one.

The future also will show whether NASA has been right in resisting some congressional suggestions that a special non-profit company be established to provide technical assistance in the *Apollo* Program.

"In some cases setting up such a company is the best way to get on with a job," one official said. "But it adds complications, too. You are better off without it if you don't need it. We think that we won't."

All problems taken into consideration, NASA's top officials feel that their agency in notably short order has swallowed and assimilated a tremendous increase in its funding and programing, has reorganized itself and is in a position to move ahead swiftly with confidence.

"Our new manned and unmanned space science, exploration and application programs constitute the largest peacetime research and development endeavor in the history of our country," Webb said earlier this month. "The U.S. space program, as now organized, is truly a national effort."

That effort is now on its way.

\*\*

# Apollo Team to Be Chosen by mid-'62

*One prime system contractor, three or more associate primes to head huge list of contractors in \$10-billion undertaking; a report on the major technical problems*

A DEADLINE of June 30, 1962, is being set for assembling of the giant industrial team which will undertake the building of the *Apollo* lunar spacecraft at an estimated cost of \$10 billion.

This deadline will leave just a little more than five years to construct the hardware to accomplish the hoped-for U.S. manned landing on the moon in 1967. At least 10 *Apollo*s will be built.

After months of deliberation, NASA has decided in recent days to handle development and production of the whole *Apollo* spacecraft under the direction of one prime systems contractor, with at least three associate primes. There will be some 5000 supporting subcontractors and vendors.

Here's the new industrial plan:

—The prime systems contractor, to be named next month, will build the three-man *Apollo* command module and its immediately connecting service module. (The latter module will be left behind on takeoff from the moon for the return to earth.)

—In about two months, NASA will ask for proposals to select associate primes to develop 1) the lunar landing propulsion module, 2) the complete guidance and control system, and 3) the orbiting laboratory module. Contracts for the three systems are to be awarded by June 30, 1962, to associate primes who by that date will, in turn, have lined up subcontracting teams.

From an industry standpoint, the building of *Apollo* is thus to be approached somewhat in the manner of the Navy's *Polaris* program.

The *Apollo* spacecraft is managed by the new Manned Spacecraft Center

headed by Robert R. Gilruth being set up at Houston, Tex. Gilruth in turn reports to the Office of Manned Space Flight in Washington, directed by D. Brainerd Holmes, where the entire lunar effort is being supervised by NASA.

• **Money picture**—Some \$200 million is available under the FY '62 budget for *Apollo* spacecraft R&D. But no money has been released, pending contract awards.

The FY '63 budget is expected to include a sharp increase—probably around \$535 million—to get the program rolling into high gear. By FY '64, more than \$1 billion a year probably will be pumped into the spacecraft.

NASA officials connected with the program feel that over the next five to eight years the cost of the spacecraft will total in the neighborhood of \$10 billion. Fully half of this figure may go to the prime systems contractor for systems engineering and for building the command and service modules.

The *Mercury* program, which is being phased into *Apollo* after the first manned orbital flight, will continue under the Houston Manned Spacecraft Center as an interim step to gain more technical inputs for *Apollo*.

At least three and possibly four manned three-orbit *Mercury* shots aboard *Atlas* are planned. In 1963-64, about three 18-orbit flights have been scheduled. Proposals also are being considered for putting a biological *Mercury* containing a monkey and other specimens into orbit for 14 days and building a larger capsule to orbit either one or two men for as long as a week.

Moreover, an orbiting *Mercury* capsule will be used with a maneuvering *Agena B* in a rendezvous experiment to determine the feasibility of this approach for assembling a lunar vehicle in space (M/R, Nov. 6, p. 18)

• **Technical problems**—Of the myriad of problems facing manned spacecraft designers, three seem to overshadow all others: radiation shielding, micrometeoroid protection and re-entry.

By careful shaping of the lunar trajectory, spacecraft designers are confident that they can avoid the high radiation levels encountered in the Van Allen belts. However, they point out even if the mission were aborted and the only means of return were through these radiation belts, the crew would be relatively safe due to their high-speed passage and the protection offered by the spacecraft structures and equipment.

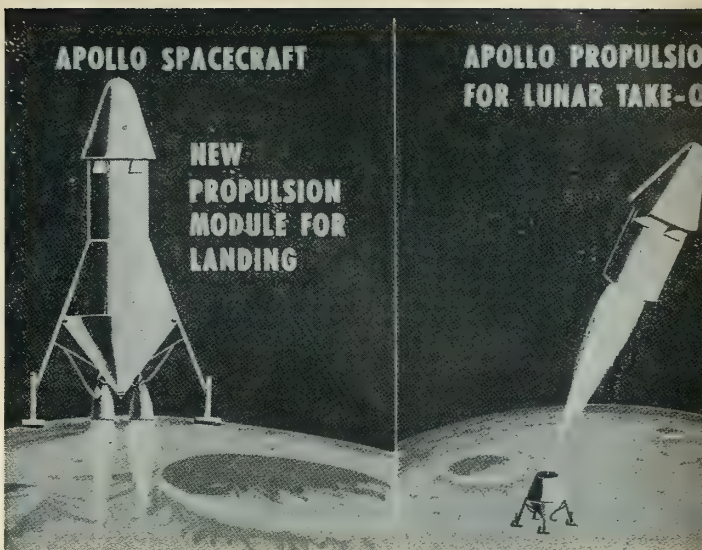
The craft's structures and equipment also will be the main shield for the crew against solar radiation. NASA designers point out that ablative material provide protection from all kinds of radiation and for that reason are almost adequate within themselves. By spot-shielding to protect vulnerable parts of the craft, the hazard can be even further reduced.

However, no matter what steps are taken to shield the crew, they will not be sufficient protection against high energy protons streaming from the sun during periods of solar activity. Therefore, a system of "weather forecasting" solar storms will be needed before the *Apollo* craft is allowed to venture





ONE-THIRD-SCALE model of probable Apollo re-entry vehicle design is tested in Langley tunnel.



LUNAR LANDING of Apollo (left) will probably be made with solid rockets; takeoff (right) may use  $\text{LH}_2\text{-O}_2$  combination.

from the earth's protective atmosphere. If the craft were caught in space during increased solar activity, the crew would have to abort the mission and return to earth.

The whole area of the biological effects of solar radiation and the effectiveness of shielding materials is still very imperfectly understood. For this reason, the 14-day-orbit satellites will carry live recoverable experiments. It is necessary to recover the specimens, according to one NASA official, in order to assess the cellular and neural damage which may not become apparent until many days after exposure.

Another danger of the space environment which must be taken into account by spacecraft designers is the possibility of micrometeoroid penetration of the craft. To illustrate the seriousness of this problem, NASA engineers point to the fact that we know very little about the densities or mechanics of discrete particles in space. And, since earth simulators are inadequate to dispel our ignorance, experts disagree by several orders of magnitude on the effects of particles on the spacecraft.

The Russians, it is noted, revealed that Titov's *Vostok II* was "dented" by meteoroid impacts. The question that still has not been answered is what the Russians mean by "dented".

By assuming the worst possible conditions, the spacecraft designers feel, they can provide a mechanism to defeat particle penetration. This, they believe, is necessary to safeguard the crew from the secondary effects—ionization and ricochet. Again, they stress that the

ablative material of the spacecraft offers some protection to the crew. And, by providing double-walls with a damping material between them (M/R, Oct. 30, p. 32), they can defeat the penetration problem.

The fuel tanks, as well as the manned command module, must be protected from meteoroids. However, according to one NASA engineer, this can be accomplished by using ablative materials on the afterbody sections and without the use of double-walled structures.

Much more data on the mechanics, density and penetration effects of micrometeorites is expected to be available by the time the *Apollo* craft is ready for launch.

• **Re-entry problem** — After approximately two years of testing models of various re-entry bodies, it appears that a spacecraft with an lift-to-drag ratio of .5 will be used for the *Apollo* mission. The actual shape of the vehicle will be either a rounded half-cone or a symmetrical, blunted cone. In either case, the re-entry vehicle will be equipped with control flaps for maneuvering in the atmosphere.

With the vehicle hurtling into the atmosphere at 25,000 mph, the effectiveness of an ablation heat shield is brought into question. Extremely effective in blocking convective heat transfer, the ablation materials, it is feared, might be relatively transparent to radiative heat transfer.

A solution to this problem might be found in the use of charring ablation materials such as phenolic nylon or fiberglass phenolic. More detailed

studies of these materials are necessary, however, to insure that they will be strong enough to withstand flight vibration, noise and thermal shock.

As the entry speed increases, NASA engineers point out, the experimental and theoretical knowledge available is meager, particularly in the areas of non-equilibrium chemical behavior, radiation heating and extensive ionization. More attention, they claim, should be devoted to experimental programs in these areas.

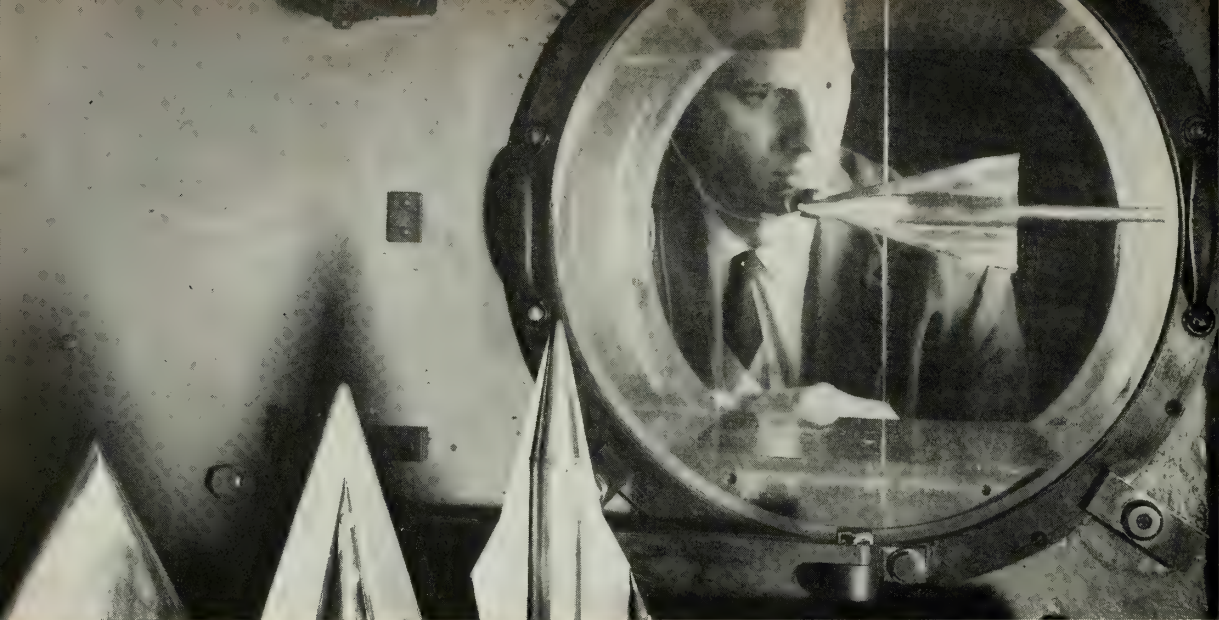
• **Utilize the crew**—One of the major objectives of the spacecraft designers is to make maximum use of the crew during the flight. The three-man *Apollo* team, they say, will not merely go for the ride but will perform whatever operations do not require a reaction time beyond that of man.

Onboard control of the mission they stress, is implicit in manned flight of any vehicle. This is especially true when the flight time is long, communications with the earth are tenuous and unknown situations are likely to occur.

This decision to utilize the crew creates several problems for the designers, such as determining the functions within mans' reaction time, designing and building onboard displays of the guidance and navigation parameters and determining how to get the most out of the crew. The planned flights in earth orbit using both the Mark II *Mercury* capsule and the *Apollo* spacecraft should provide answers to these problems.

One of the chief ways in which the engineers hope to utilize the *Apollo* crew is as a backup for more precise,





**MODELS USED** in Langley's Hypersonic Wind Tunnel to study rocket-boasted glide vehicles include (from left): a basic flow and heat transfer wing, a basic wing-body combination, and two re-entry vehicles. Tests are conducted at Mach 18.

automatic systems. For example, during the midcourse phase of the flight, one of the crew could take optical sightings on pre-determined stars for course corrections. The concept, one NASA engineer pointed out, is analogous to a ship's captain taking periodic sightings on the stars with a sextant.

Other areas in which the crew may be used include:

- Picking out the lunar landing site and monitoring the ship as it lands.

- Checking out and launching the ship from the lunar surface.

- Exercising control during re-entry in order to determine the landing point on the earth.

Two of the main advantages of putting the crew to work are: it reduces the complexity of the module construction by allowing the men to act as back-up for some of the system components; and it enhances the overall safety and reliability of the spacecraft by permitting the crew to monitor the launch countdown, initiate escape in the event of a malfunction or override ground commands.

This reliance on crew functioning has caused NASA to specify a "shirt-sleeve" environment within the command module. This eliminates the pressure suit worn by the *Mercury* astronauts because of its limited mobility and the excessive amount of time required to get into this type of suit. Therefore, there is a requirement for a "quick-don" suit to protect the crew in an emergency. This suit must contain its own integral life support system.

- **Spacecraft components** — Within

the command module will be all of the equipment necessary to fly the spacecraft and to provide a safe environment for the crew. This includes the guidance and navigation systems, communications, life support and re-entry and landing systems. Also, the propulsion required for mid-course path control and velocity corrections on the return flight from the moon.

The service module—located to the rear of the command module—will consist of the experiments and components necessary to accomplish the mission while on the lunar surface. The propulsion system for the return flight will be housed, to a large extent, within this module.

The final module is the propulsion unit used during the out-bound trip for path control and velocity corrections. Also within this module will be the lunar landing package—a system with telescoping legs for landing on the lunar surface. This will also act as a launch pad for the command module's take-off on the return trip.

In discussing the propellants to be used in the *Apollo* spacecraft, NASA officials stress that the selection will be based on the present state of the art. Specifically, if the engines are liquid, the propellants will be the type used in the *Agena-B*; if solid, which is considered unlikely, they would be of the type used for the *Minuteman*.

The propellant combination of the *Agena-B* consists of Unsymmetrical-dimethylhydrazine and Red Fuming Nitric Acid. The advantages of this type of propellant system are: excellent storability, hypergolic ignition and

smooth combustion, regenerative cooling is relatively easy and the state of the art is well advanced as a result of *Agena* engine development.

A back-up program will be initiated, according to one NASA official, on a Liquid Hydrogen-Liquid Oxygen system. However, whether such a system can be used will depend on the state of the art at the time of the *Apollo* flights. It is unlikely that this more exotic propellant combination will be used on early flight missions—although it may be included in later flights.

Power for the *Apollo* craft will be supplied by chemical batteries and a fuel cell. The bulk of the total wattage required will be provided by the primary fuel cell—a non-regenerative device that will provide electrical power by fuel combustion. The power requirements for the *Apollo* craft, according to one NASA official, are: 1.5 kw continuous power and 3 kw peak power. Although the state of the fuel cell art is not as advanced as NASA would like, the system offers clear-cut advantages over other power systems such as solar cells or dynamic power sources.

Solar cell, NASA engineers say, are out because of the large appendages that would be required to produce the power and the necessity for a large storage capacity while the system is operating in the shade. NASA discounts dynamic power sources because of the rotating machinery involved and the lower efficiency obtained as compared to the fuel cell.

These are the principal problem areas faced today by the designers of the *Apollo* spacecraft. ■



## Microdot Awarded Contract on Midas

LOS ANGELES, CALIF.—Contracts in excess of \$225,000 have been awarded to Microdot Inc. by Philco Corporation's Western Development Laboratories for UHF narrow-band data link transmitters and subassemblies to be flown in the Midas missile alarm satellites.

The Midas project, under cognizance of the United States Air Force, is aimed at development of a national early warning capability through multiple satellite coverage of the earth's surface via infrared detectors. Philco, with responsibility for the instrumentation, is an associate contractor to the Air Force. Lockheed Missiles & Space Company, prime system contractor, is responsible for the total vehicle and ground elements of the system, integrating associate and subcontractor efforts.



Microdot model 2406A UHF Telemetry Transmitter, similar to units now in production for the Midas satellite program.

In May, 1960, Midas satellite was launched into near perfect orbit 300 miles in space. This was followed by another successful orbit in July of this year. And, last month, Midas IV— in orbit—spotted the launch of a Titan CBM within two minutes after the missile left the launching site. Continuation of test firings are anticipated with the program remaining a high priority national development.

For Midas, Microdot will supply their Model 2406A Telemetry Transmitter modified to include self-monitoring and telemetering of its own operation. The transmitter is miniaturized, pressurized, and includes its own solid state power supply. Reduction in size is gained through use of a unique automatically stabilized circuit, with the output frequency referenced directly to a quartz crystal. The transmitter weighs 12 pounds. Similar Microdot telemetry equipment has been a part of such projects as Pioneer V, Jupiter, Atlas, Pershing, Redstone, and Echo I.

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## Putting outer space in Pasadena

How will sub-zero cold and intense heat and light from the Sun effect planet-bound spacecraft moving through the void of outer space? The scientists and engineers at Cal Tech's Jet Propulsion Laboratory think they know.

But they're building this giant space simulator at JPL's Pasadena facility just to make sure.

The 80-foot high simulator will soon begin environmental tests on the Mariner—first spacecraft scheduled to fly-by Venus. In a 25-foot-in-diameter chamber, the Mariner may be exposed to a vacuum of  $5 \times 10^{-6}$  millimeters of mercury, a wall temperature of  $-320^{\circ}\text{F}$ , and a radiant flux of sun light and heat found as near to the

Sun as Venus and as far away as Mars.

Next-to-the-real-thing testing is part of any R & D work. But in JPL's job—exploration of our Moon and planets—the stakes were never higher.

The odds for JPL's (and the nation's) success in space are only as good as our scientists and engineers are good. JPL is looking for good people. The best people. Why not write to us and find out if you can improve the odds.

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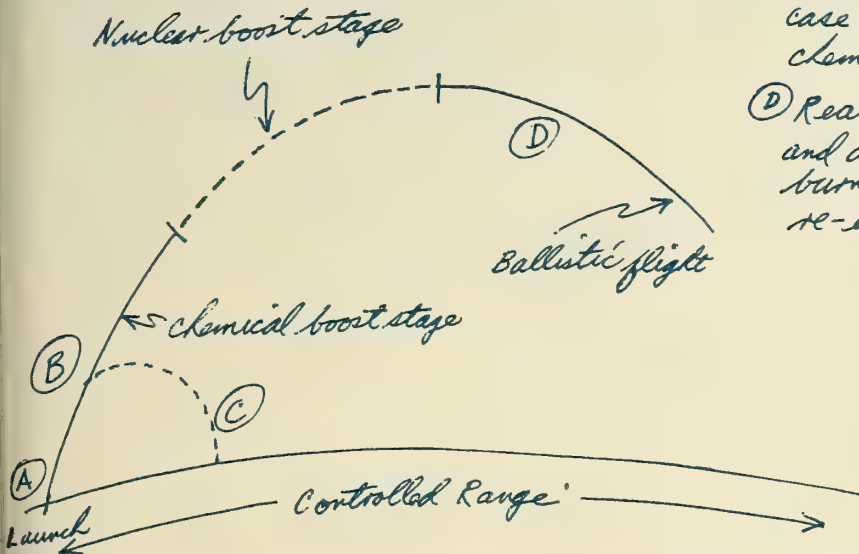


## MARTIN NUCLEAR ROCKET PROGRAM

- REACTOR DESIGN
- PROPULSION REACTOR START-UP
- NUCLEAR ROCKET SAFETY ANALYSIS
- RADIATION EFFECTS ON ROCKET SYSTEM
- FUEL ELEMENT DEVELOPMENT
- VEHICLE DESIGN
- CRYOGENICS

### Safety Requirements

- Safe disposition of reactor in case of launch pad abort
- Rapid reactor start-up without risk of a nuclear excursion
- Safe disposition in case of abort during chemical boost
- Reactor fragmentation and aerodynamic burn-up during re-entry



## SAFETY ASPECTS OF NUCLEAR ROCKET FLIGHT TESTING

Safety is one of the many areas receiving continuous attention in the U. S. nuclear rocket program. Tests must be conducted to obtain data, to develop safety systems, and to demonstrate safety.

During the past several years, Martin has gained valuable experience in the safety field through its investigations and tests concerning the use of radioisotope-fueled generators for auxiliary power in space. Analytical investigations of nuclear rocket safety conducted by the company under the RIFT (Reactor in Flight Test) program for the National Aeronautics and Space Administration are being continued. The U. S. Atomic Energy

Commission's SNAP program, under which The Martin Company developed the radioisotope-fueled generator that powers two radio transmitters in a Transit satellite, involved exhaustive safety studies and tests. This was the first use of atomic energy in a space vehicle. Experience in computer analysis of booster behavior, flight test of large boosters (VIKING, VANGUARD, TITAN and PER-SHING) at Cape Canaveral, re-entry, system integration, missile test range control and rocket destruct systems, as well as extensive experience in nuclear technology, has been invaluable in the development of technical capabilities and facilities required for these investigations.

**MARTIN**



In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

These **SILICON** modules come epoxy encapsulated, and operate over a temperature range of  $-55^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ . And these same reliable **DIGITAL** circuits are available packaged on plug-in circuit cards. These Delco **MODULES** are environmentally proved to: **SHOCK**, 1,000G's in all planes. **VIBRATION**, 15G's at 10 to 2,000 cps. **HUMIDITY**, 95% at max. temp. **STORAGE AND STERILIZATION TEMP.**  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . **ACCELERATION**, 20G's. Designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Data sheets are available. Just write or call our Military Sales Department.

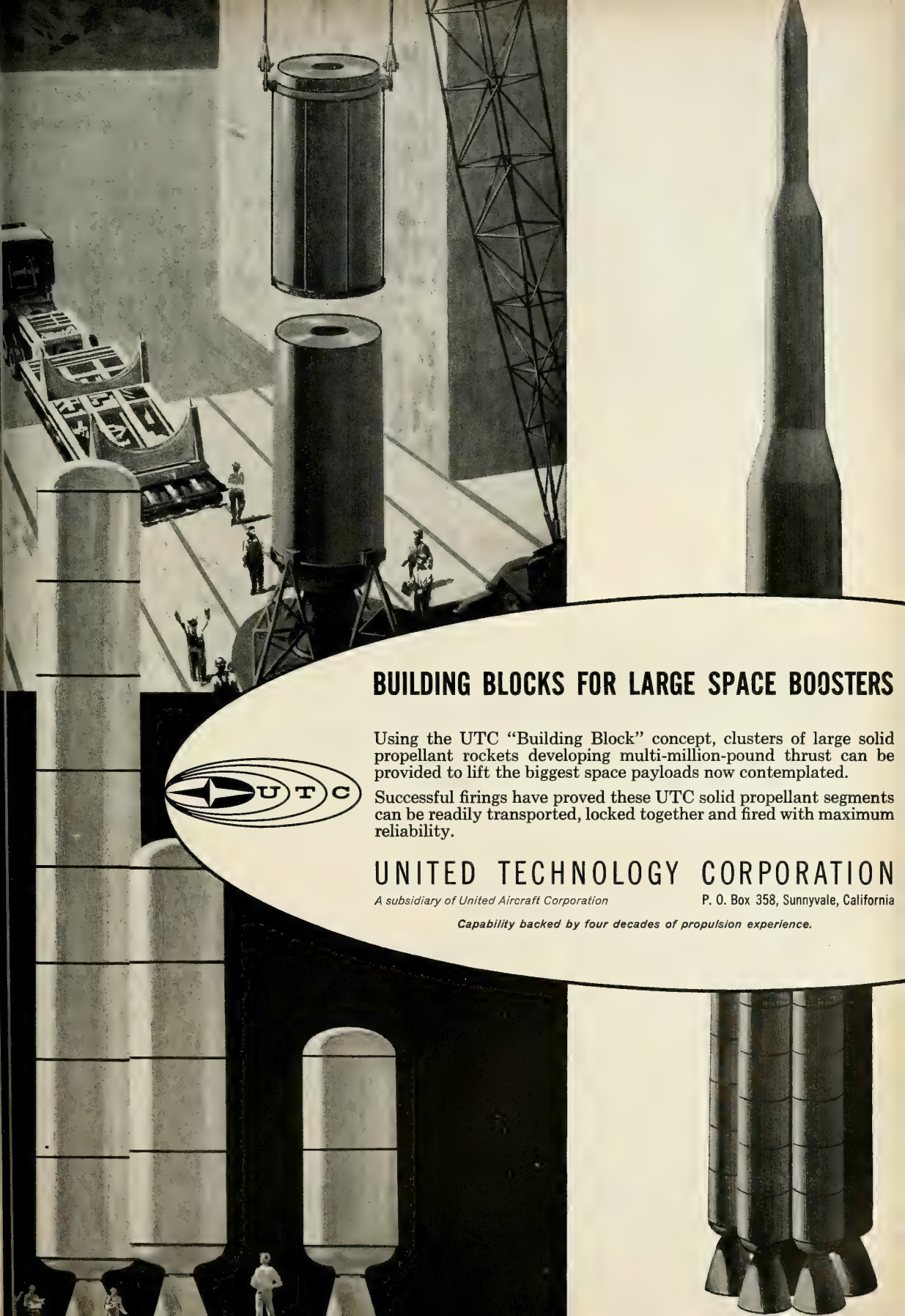
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# Market Expected to Total \$5 Billion—or More—Over 3 Years

*Half of agency's R&D spending, much of outlay for new facilities will go to satisfy electronics/optics requirements*

*NASA USES lunar landing simulator to determine pilot ability to control braking.*





AS NASA'S budget booms, so do its electronics and optics requirements. Not a big production factor, this nevertheless will result in a substantial dollar increase for the entire industry.

M/R editors estimate that half the space agency's \$1.3-billion authorization for R&D alone will go for advanced electronics and optical systems.

Representing an outlay of between \$600-\$660 million, the principal requirements will be for satellite instrumentation (over \$215 million), man-in-space programs (at least \$100 million), *Saturn* development (over \$80 million), and tracking and data handling (nearly \$40 million).

In addition to these expenditures, NASA will spend nearly \$1 billion over the next three years for new facilities. A sizable portion of this will go for electronics and optical hardware.

The trend in recent years has been for electronics requirements for both the military and for NASA to equal about 50% of total expenditures for hardware and R&D. If this trend continues—and there is no apparent reason why it should not—NASA electronics needs will top \$5 billion over the next 3 years.

Increased emphasis in new areas may nudge this estimate even higher. For example, the current excitement concerning the need for orbital rendezvous might change the picture. NASA officials have indicated that up to \$160 million may be spent next year in this area. Some of this would be for development of simulators to teach astronauts rendezvous and docking techniques. Other problem areas will be tracking, fine thrust control and better guidance techniques.

• **Instrumentation**—An R&D salesman for optical and electronic hardware should go wild with anticipation over NASA's instrumentation requirements during the next few years.

The space agency is authorized to spend nearly \$220 million for its scientific, meteorological, and communication satellites during FY '62. For studies and hardware development in its lunar and planetary-exploration program, from \$80-90 million will go for electronics/optics R&D.

On top of this, NASA's huge facility construction will open up broad markets for ground telemetry, test and checkout equipment, dynamic and environmental test systems, recorders, and other types of equipment needed at large launch and test facilities.

About \$200 million will be spent to build the massive static test firing facility at a site not yet selected in southwest Mississippi. Under the direction of Mar-

shall Space Flight Center, the facility will be finished in three years. Later expansion is expected to push the total to over \$400 million. Construction starts next spring and contracts for instrumentation will follow shortly thereafter. NASA's problem now is to determine the exact mission of the facility and the types of stands required.

A similar situation exists for the Space Task Group. Its new Manned Space Flight Laboratory at Houston, Tex., will initially cost about \$60 million, and its completion will also require about three years. A large portion of the equipment requirements will be for advanced simulators and a variety of test equipment.

The Cape Canaveral extension for *Saturn* and *Nova* launch facilities will cost over \$500 million. Construction starts next spring; completion date is 1966.

Biggest electronics outlay will be for blockhouse instrumentation, test and checkout equipment, electronic instruments for the new bio-medical center, and an extensive closed-circuit TV system throughout the vast complex.

• **Guidance and control**—G&C responsibilities are spread throughout half the NASA establishment. Marshall is responsible for launch vehicles development. To that end, it has control over G&C systems used up to the time the

vehicle is operational. Thus, Marshall has been concerned with the *Centaur* guidance, electronics, and control systems and with the early G&C for *Saturn*.

A decision still must be made as to which Center—Marshall or JPL—will manage development of the advanced systems for *Saturn*. JPL has responsibility for mission planning and development of spacecraft for lunar and interplanetary exploration. For this reason, it has a direct interest in the type and capability of guidance chosen for the big booster system.

Langley developed the *Scout* launch vehicle, including its inertial reference system. Also, this Center is developing space-rendezvous and docking techniques for manned spacecraft.

Ames also has responsibility for selected research in spacecraft stabilization control and orientation. Much of its studies have centered on human capability for guidance, control and navigation of multistage launch vehicles.

In other programs, such as *Nimbus* and *OAO*, Ames developed G&C criteria. The Center is working with M.I.T. now on *Apollo* guidance. The group will study the overall problem with regard to mission requirements and may possibly study alternate G&C configurations not being investigated by M.I.T.

Both Lewis and Langley are studying lunar soft-landing problems.

Goddard originally directed development of the control system for *Mercury*. Now that Space Task Group is a separate entity, it assumes responsibility for Project *Mercury* and *Apollo* and, of course, the development of their G&C systems.

Goddard retains direction of control and stabilization systems for all scientific and application satellites except two groups: the micro-meteoroid and *Echo* satellites being developed by Langley.

NASA expects to spend about \$16 million during FY '62 for R&D of guidance and control systems. The total for *Apollo* is expected eventually to be from \$20-30 million.

R&D expenditures in this field are not expected to change much over the next few years. Total market figures for complete systems including GSE will rise steadily from the present \$85 million to roughly \$500 million in the next 5 years, according to industry estimates.

These figures, some observers feel, could be reduced even with the expected increase in number of units required. They expect up to 75% reduction in unit costs over the next 10 years.

There are still many technological problems in this field, but in general

#### M/R Estimates\* of NASA FY '62 Expenditures for Electronics/Optics R&D

|                                                                     | (Millions)           |
|---------------------------------------------------------------------|----------------------|
| Research Grants & Contracts                                         | \$ 3.0- 3.5          |
| Life Sciences                                                       | 7.0- 11.0            |
| Sounding Rockets                                                    | 3.4- 4.0             |
| Satellites:                                                         |                      |
| Scientific                                                          | 72.7-                |
| Meteorological                                                      | 50.2-                |
| Communication                                                       | 94.6-                |
| Lunar & Planetary Exploration                                       | 80.0- 90.0           |
| Mercury                                                             | 38.0- 43.0           |
| Apollo                                                              | 60.0- 70.0           |
| Launch Vehicle Technology                                           | 10.0- 11.0           |
| Launch Operations Departments                                       | 1.0-                 |
| Spacecraft Technology                                               | 4.0-                 |
| Scout                                                               | 1.0- 1.4             |
| Centaur                                                             | 6.0- 8.0             |
| Saturn                                                              | 80.0- 95.0           |
| Tracking & Data Acquisition (and advanced communication techniques) | 38.6-                |
| Nova                                                                | 18.5- 20.0           |
| <b>SUB TOTAL</b>                                                    | <b>\$568.0-618.6</b> |
| Support of NASA Plant (in-house R&D)                                | 40.0- 45.0           |
| <b>TOTAL</b>                                                        | <b>\$608.0-663.6</b> |

\* Based on NASA authorization for FY '62, these figures could be cut because of \$75-million subsequent slash in NASA appropriations for R&D; nevertheless, NASA's January supplemental requests are expected to keep the figures where they are now.





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G&C experts believe that state-of-the-art will parallel requirements.

Toughest problem may be in recovery or landing manned vehicles safely and at a selected point. Several companies are studying the problem — not only for *Apollo* but for the Air Force's *Dyna-Soar* boost glider.

In brief, these are some of the other G&C requirements noted by NASA scientists:

- A simple means for locating and identifying celestial bodies.

- More versatile timing, sequencing, and logical control for operation of scientific instruments in unmanned spacecraft on planetary orbital or landing missions.

- Better methods for sensing altitude and altitude-change rate and cross-velocity, particularly for soft-landings.

- Eventually, celestial midcourse guidance and navigation capable of angular measurements to an accuracy of 5 seconds.

- Attitude and inertial sensors accurate to 0.001° (these needed by 1964).

- During this decade, a guidance computer capable of performing navigation, storage and processing of scientific data, and spacecraft control during near-surface maneuvering for exploration.

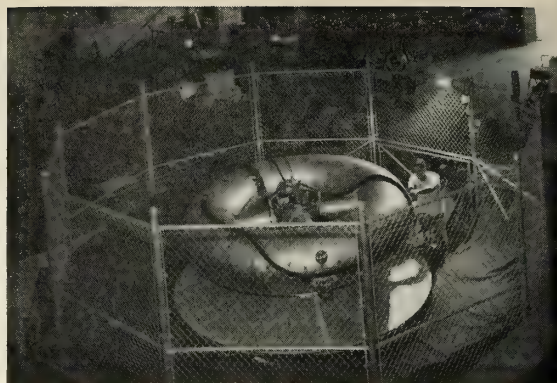
- **Tracking and data handling**—At present, Goddard is responsible for tracking and the acquisition, processing, and reduction of data for all space missions. It operates the Minitrack net as expanded from the early system set up for the International Geophysical Year. This includes 13 Minitrack stations and a new station at Fairbanks, Alaska.

Also, Goddard is responsible for the *Mercury* net, which consists of an 18-station global complex. Langley directed the establishment of the \$80-million system and now manages the ground instrumentation and tracking facilities for Goddard.

Goddard actually operates five stations, DOD handles the others.

JPL has responsibility for the new Deep Space Instrumentation Facility (DSIF), which will be capable of tracking and communicating with deep space probes and manned lunar flights of the future.

All of the existing and planned facilities are continually up-dated. R&D authorization of nearly \$40 million this



LANGLEY TECHNICIAN prepares 10-ft.-diam. (1/3 scale) model of possible erectable manned space station for test in which model is spun to simulate artificial gravity technique.

year (FY '62) is indicative of the extent of this work.

As it stands, Minitrack operates in the 136-mc band. It provides extensive narrow-band coverage, but is limited by information rates.

A new wideband net is now being integrated with the system. The first station, at Fairbanks, uses an 85-ft. dish providing very high gain. System electronics will be checked out by the end of 1961.

Two more stations will be installed: one will be located near the East Coast of the U.S.; the other will be installed, probably in Europe, by mid-1963.

The new stations will operate in the 136-mc band and at (approx. frequencies) 400 mc, 1700 mc, and 2300 mc. Antennas will have multiple feeds, but not all stations will necessarily be provided with equipment to receive each frequency.

First uses of the expanded system will be for the R&D phase of the *Nimbus* weather satellite and possibly for S-27 (the Topside Ionosphere Sounder), and for *OGO*, *OAO*, and *OSO* follow-on satellites.

Each of the three new facilities will cost an estimated \$5 million.

DSIF consists of three stations spaced 120° apart longitudinally. Located at Krugersdorp, South Africa, Woomera, Australia, and Goldstone Lake, Calif., the sites employ 85-ft. dishes. JPL maintains net control at Pasadena, Calif.

This system is considered adequate for the next few years, but for deep outer-space probes JPL is developing 250-ft. reflectors.

The *Mercury* net has yet to be operationally checked out with an orbital vehicle. It had a partial test this year during each of the two suborbital manned flights of the capsule.

Launch of a 150-lb. electronic package (carrying C-band and S-band trans-

missiles and rockets, November 27, 1961



ponders, telemetering transmitters and receivers, and two Minitrack beacons) by a *Scout* vehicle on Nov. 1 was aborted. Firing was to check out the real-time computing center at Goddard and the communications links between Goddard and the range stations.

To augment the 16 fixed ground-tracking stations in the *Mercury* net, two Navy C-4 tracking ships are being instrumented. Outfitting of the two MARS (Mobile Atlantic Range Stations) ships is being performed by Sperry-Rand. Eventual cost is estimated at near \$50 million.

For the future, many experts believe, the *Apollo* program will require outfitting of at least two more similar vessels.

• **Evolution**—Modifications and overall systems improvement over the next 5-10 years will be extensive, but evolutionary, according to NASA officials. Some of the major requirements include:

—Better communications link for data acquisition by Goddard's processing center. Radio has been suggested. The Center currently uses teleprinter tape for transmission of tracking data for processing and orbital computation by the IBM 7090's.

—Reduction in power requirements for near-space tracking. In time, parametric amplifiers may be used, together with more high-gain antennas.

—More efficient, higher-powered transponders are needed, however, for deep-space probes.

—Improvements in optical-tracking readout time.

—Decrease in data reduction time. At present, 1 hour tracking time yields 1 hour data processing time. The trend toward more elliptical satellite orbits is expected to further complicate tracking/trajectory computation problems. Also, NASA expects to launch 124 satellites over next 9-10-year period, which will further complicate problems.

More information per watt of power seems to be the order of research. More vehicles means more tracking requirements, more capacity for ground data-collecting equipment, and more capability to operate over longer ranges. Improvements are needed all down the line—including a greater research effort in information theory.

—More efficient pre-editing procedures to reduce data before final processing.

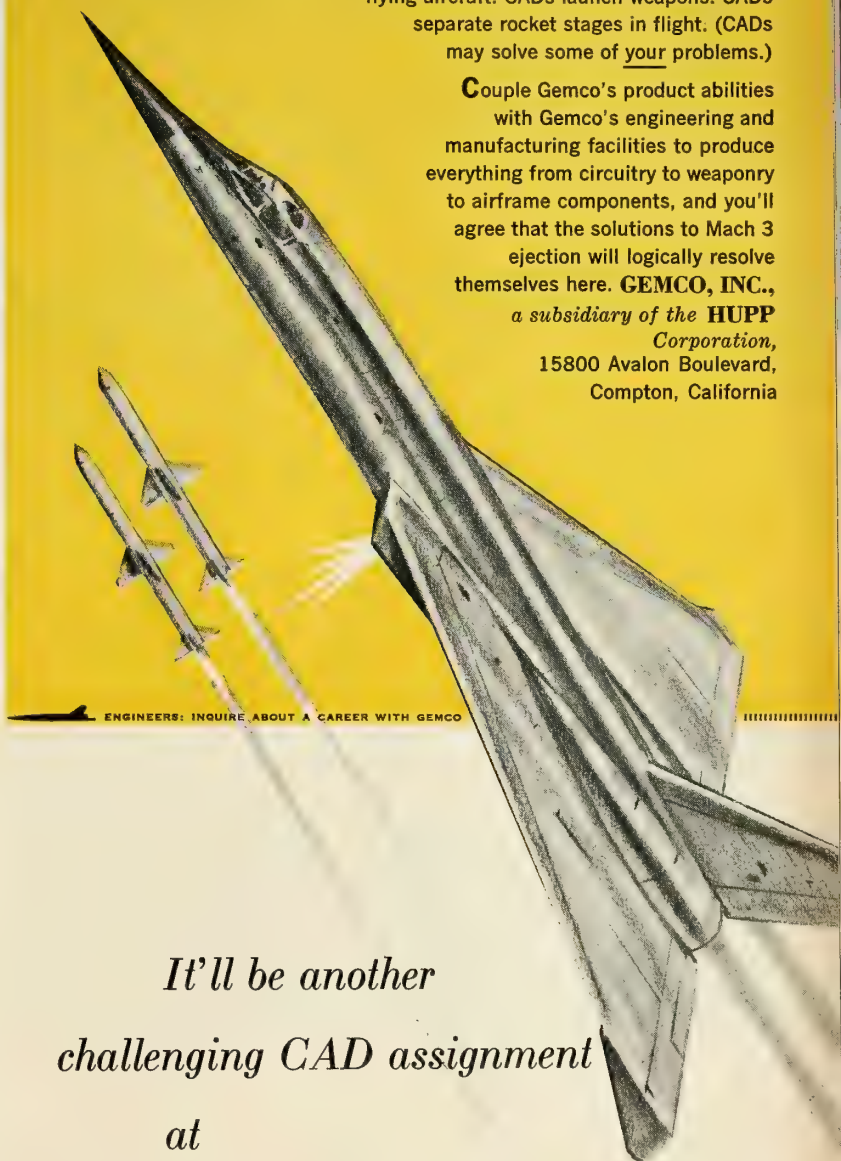
These are but a few of the many problems requiring early solution. Each area is being studied or will soon be tossed out to industry for R&D. The two areas of greatest effort, however, will continue to be in network operations and communications. Funding for FY '62 alone for each is over \$14 million and \$9 million, respectively. ■

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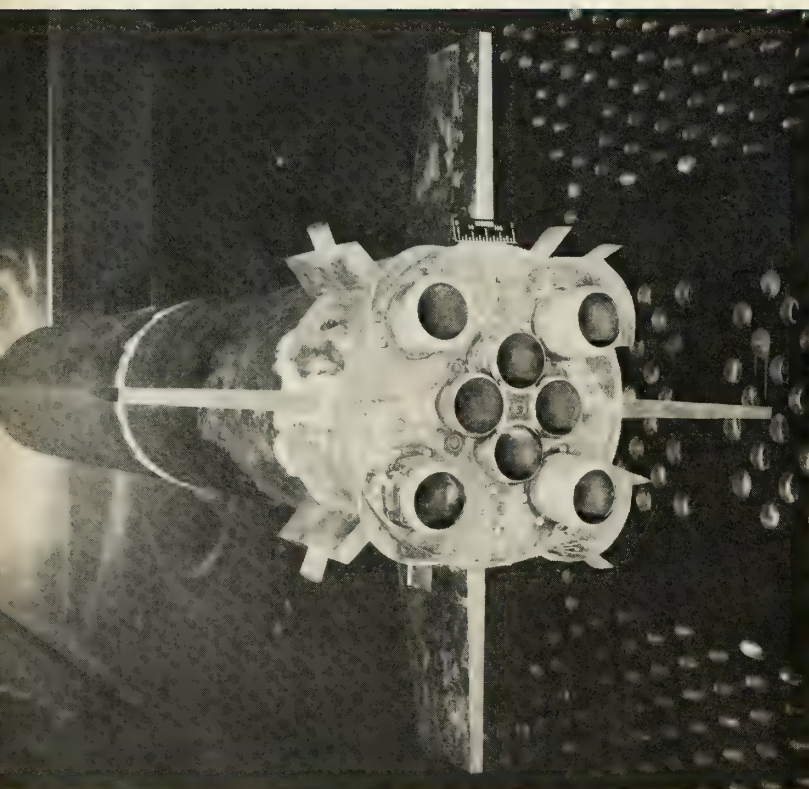
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# Mastery of Hydrogen Vital to Success

*Major programs are geared to solution of the varied problems posed by the element; \$96 million for overall R&D*



OPERATING MODELS such as this version of the Saturn Apollo booster are almost as difficult to build as the original.

THE KEY TO the U.S. space program may well be hydrogen—the fuel that promises more than a 30% increase in performance but poses a technology difficult to master.

Every major NASA propulsion effort depends on the element to some extent.

—It is the heart of the *Centaur* program, aimed at giving the U.S. a high-performance, general-purpose launch vehicle capable of handling payloads too heavy for *Thor* or *Atlas-Agena B* vehicles and too light for economical usage of the massive *Saturn* series.

—*Saturn* itself is being paced by the element, since all upper stages are slated to use hydrogen as a fuel. Hydrogen development is closely allied to a completely successful *Saturn* program.

—The *Rover* heat-transfer nuclear rocket will use hydrogen—and it is safe to assume that any follow-on nuclear engine will call for it.

—Several funded space projects are directly dependent on hydrogen-firing booster vehicles; substitution of another vehicle means fairly drastic reductions in project payload and mission.

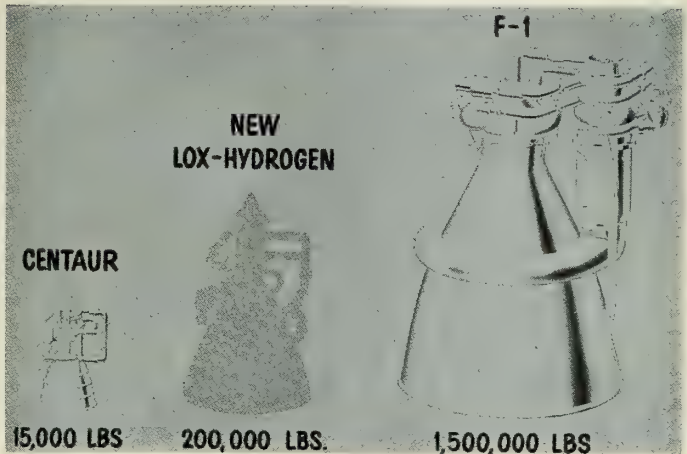
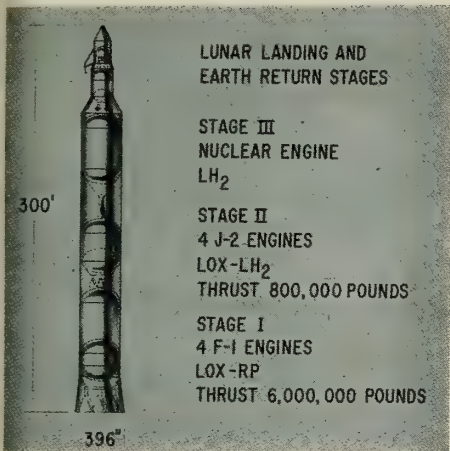
—The huge *Nova*-class vehicles would be committed to hydrogen in the upper stages regardless of the nature of the first two stages.

And there are hydrogen-induced setbacks in every one of these programs.

The primary hydrogen problems are in the heat transfer area. This includes storage, pumping, nozzle flow and cooling.

• **Insulation & zero-g**—Tankage alone is a complicated field. The hydrogen is useful to NASA only in the cryogenic state, and keeping it cold in space any length of time is not easy.





ULTIMATE Saturn vehicle would mate the C-4 with J-2 engines, nuclear upper stages. Here are NASA engines in development.

A pressurized system raises many questions—such as the effect of the pressurizing gas on the liquid hydrogen, and the reverse of this—the effect of the cold hydrogen on the pressurizing gas.

The position of the liquid in the tank at zero gravity is important. Preliminary experiments have shown that pressure rises faster under this condition than was previously thought. What are the effects of attitude control on a partially emptied tank? And again, the reverse question—what is the effect of a partially filled tank on attitude control?

The general dynamics of motion in this area is a complex problem.

In the propulsion unit itself, the hydrogen is in its critical range. Cooling of nozzles, pump configurations, insulation and other allied aspects are extremely difficult to anticipate because of the peculiar properties of the fuel under critical conditions.

One big problem at the Marshall facility involves the use of hydrogen on a lunar return trip. All of the above areas contribute to this simple question—can the fuel be used at all to return to earth?

There are several approaches to this problem. One of these, proposed by Thiokol Chemical Corp., is under evaluation by Lewis. This involves a return mission capability through "space-storable" propellant systems such as oxygen fluoride and methyl monohydrazine or a boron fuel (B<sub>2</sub>H<sub>6</sub>). These systems move the critical temperature to about -194° F instead of the -423° F liquid-hydrogen range.

In the big booster areas, the relative positions of solids and liquids have not yet been fully resolved. No major de-

cisions are expected before next January.

Some NASA propulsion experts maintain that liquids are ahead and the U.S. is much closer to a liquid *Nova* than to one using solids. There is strong feeling in NASA against crash programs in big solids.

A small solid vehicle, resembling *Saturn C-1* in size and capability, looks attractive in that it might be more reliable; larger sizes, however, bring problems—one scientist pegs the problem area at above 12-million-lbs.-thrust.

The consensus seems to be that no one has anything against solids, that starting development in this field is advisable, but crash programs are unnecessary.

The rendezvous approach currently being mentioned in connection with the manned lunar effort is definitely a point in favor of liquids. NASA is considering a returnable command module for *Apollo* weighing about 12,500 lbs. A lunar landing system must be capable of 50,000 lbs. deposit and about 13,000 lbs. return. Thus a *Nova* is necessary for direct flight and the *Saturn* series for the orbital approach.

Within this framework, the *Saturn C-4*, 6-million-lb.-thrust first stage of four F-1 engines, will be the rendezvous work horse. There is some talk of upgrading the F-1 to an F-1-H or F-1-Y using liquid hydrogen. This would place the *C-4* almost in the *Nova* class. It also again underlines the importance of hydrogen technology to the whole space effort.

• **Planetary engines**—Space electrical propulsion currently carries an authorized expenditure figure of around \$6.8 million. NASA is developing three types of electrical rockets designed to meet the propulsion requirements of

deep space, the areas beyond the big chemical rockets.

The ion engines are closest to actual flight testing: some environmental space runs are scheduled for 1962. A flight version of an ion engine is being built at the Lewis Research Center for tests in harness with the Hughes unit. All electrical propulsion work is now concentrated at this center.

Development is proceeding on arc jet (electrothermal) engines and magneto-fluid-dynamic units. All of these engines are eventually to be utilized for planetary missions.

NASA's highly classified work in nuclear rocket systems is known to be progressing at a more-than-satisfactory pace. The *Rover* heat transfer rocket has an authorized price tag of around \$25.5 million, including flight test engine development.

Fiscal '62 will see the installation of liquid hydrogen turbo-pumps and liquid hydrogen-cooled nozzles in the *Kiwi-B* reactor series. Development of these components for higher-power reactor tests will also be initiated.

Work in such areas as radiation effects and shielding, hydrogen properties evaluation and the necessary instrumentation, is already in progress within NASA.

While the reactor work itself receives a great deal of public attention, there is a large amount of support effort in the many components. The effect of reactor radiation on materials at cryogenic temperatures is being studied—as are bearings and wheels at high temperatures.

• **H<sub>2</sub> headaches**—The high heat flow from the hydrogen jet to the nozzle walls means that liquid hydrogen will have to be used as a coolant. This noz-

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zle cooling problem is one of the big unanswered questions in nuclear rocket technology.

The nuclear engine exceeds even the heat flow to the nozzle wall of a hydrogen-oxygen engine. Heat flaws are expected to be 50 to 100% higher than those experienced in the  $H_2-O_2$  unit.

The whole *Kiwi-B* series of tests are intended to lead to a reactor which can be incorporated in the *Nerva* (Nuclear Engine for Rocket Vehicle Applications) engine. The *Nerva* engine is currently in early development, and NASA believes it essential to conduct flight tests as soon as possible to obtain design information—and also to provide confidence in the solution of any unexpected problems resulting from the flight environment.

The first flight tests, expected in

1966-67, will involve ballistic trajectories to exactly pre-determined impact points, using first-stage *Saturn*-class boosters. Safety measures will be such that the minimal hazard, regardless of events, is too small to really comprehend.

Continual development of this flight test system could lead to operational third stages for *Saturn*. Such a nuclear third stage would increase the escape payload of a chemically propelled *Saturn*-class vehicle by a factor of 3.

• **Overall R&D**—In the general area of propulsion development, NASA has been authorized about \$96 million—\$93 million of it in liquids. The bulk of the liquid funds are in the F-1 and the hydrogen-LOX, 200,000-lb.-thrust J-2.

Some in-house basic research is also being carried out. One example is

## NASA's Launch Schedule Through the Fourth Quarter of 1962

| Payload                                                | Launch Vehicle | Site | Period           |
|--------------------------------------------------------|----------------|------|------------------|
| Electron Density P-21 Satellite                        | Scout          | W.I. | 4th Quarter 1961 |
| Tiros IV Meteorological Satellite                      | Delta          | AMR  | "                |
| Electron Density P-21a Satellite                       | Scout          | W.I. | "                |
| Ranger II                                              | Atlas Agena B  | AMR  | "                |
| Echo Satellite                                         | Thor           | AMR  | "                |
| MA-6 (Manned earth orbital flight)                     | Atlas          | AMR  | 1st Quarter 1962 |
| Ranger III (Lunar rough landing)                       | Atlas Agena B  | AMR  | "                |
| MA-7 (Manned orbital flight)                           | Atlas          | AMR  | "                |
| Orbiting Solar Observatory (OSO)                       | Delta          | AMR  | "                |
| Electron Density P-21a Satellite                       | Scout          | W.I. | "                |
| Topside Sounder S-27 (Canada)                          | Thor Agena B   | PMR  | "                |
| Ionosphere S-51 Satellite                              | Delta          | AMR  | "                |
| Tiros V                                                | Delta          | AMR  | "                |
| SA-2 (Second Saturn C-1 launch)                        |                | AMR  | "                |
| Ranger IV                                              | Atlas Agena B  | AMR  | 2nd Quarter 1962 |
| MA-8 (Manned orbital flight)                           | Atlas          | AMR  | "                |
| Rigid Passive Communications Satellite A-12            | Thor Agena B   | PMR  | "                |
| Project Telesat (AT&T Communications Satellite)        | Delta          | AMR  | "                |
| Scout Re-entry Test                                    | Scout          | W.I. | "                |
| Energetic Particles Satellite                          | Delta          | AMR  | "                |
| Orbiting Solar Observatory Backup                      | Delta          | AMR  | "                |
| Telesat Backup                                         | Delta          | AMR  | "                |
| Tiros VI                                               | Delta          | AMR  | 3rd Quarter 1962 |
| Scout Re-entry Test                                    | Scout          | W.I. | "                |
| Venus Flyby                                            | Atlas Agena B  | AMR  | "                |
| Venus Flyby                                            | Atlas Agena B  | AMR  | "                |
| Relay Communications Satellite                         | Delta          | AMR  | "                |
| Fixed Frequency Topside Sounder                        | Scout          | PMR  | "                |
| Orbiting Solar Observatory S-17                        | Delta          | AMR  | "                |
| Relay Communication Satellite                          | Delta          | AMR  | 4th Quarter 1962 |
| Telesat Communication Satellite                        | Delta          | AMR  | "                |
| Electrical Engine Test                                 | Scout          | W.I. | "                |
| SA-3 (Third Saturn C-1 Launch)                         |                | AMR  | "                |
| Nimbus Meteorological Satellite                        | Thor Agena     | PMR  | "                |
| Ranger V                                               | Atlas Agena B  | AMR  | "                |
| Tiros VII                                              | Delta          | AMR  | "                |
| Syncom Communications Satellite (22,300-mile altitude) | Delta          | AMR  | "                |
| Telesat Backup                                         | Delta          | AMR  | "                |
| S-48a Backup                                           | Scout          | PMR  | "                |



an attempt on the part of Lewis scientists to take advantage of the "screaming" process in liquid engines. This high-frequency, high-amplitude acoustic oscillation has resulted in engine failures. This aspect was eliminated by inserting fins. The group is trying to relate the mechanism driving the high-pitched "screaming" waves to present theories of steady-state combustion.

There is also some small research effort into the burning process in solids. Part of this is geared to production of pure hydrocarbon binders which would be less reactive with high-energy additives such as lithium perchlorate.

In the *Scout* program, NASA will aim in FY 1962 for improved motor capability. Increased cone diameter, vehicle design standardization and component qualifications test completion are other *Scout* aspects due for early concentration.

Since *Delta* vehicle and engine development has been completed, all 1962 funds in this area are allotted for contractor launch services.

The *Centaur* program is in the forefront of hydrogen technology. It ran head-on into the whole hydrogen fuel development area—uncovering a host of problems with the high-energy fuel.

The *Nova* concept may be downgraded in favor of a major development effort for a *Saturn C-4* vehicle. Some NASA propulsion experts have stated a preference for building one vehicle at a time—not both *Nova* and *Saturn C-4* simultaneously. Primary reason—a better job will be done.

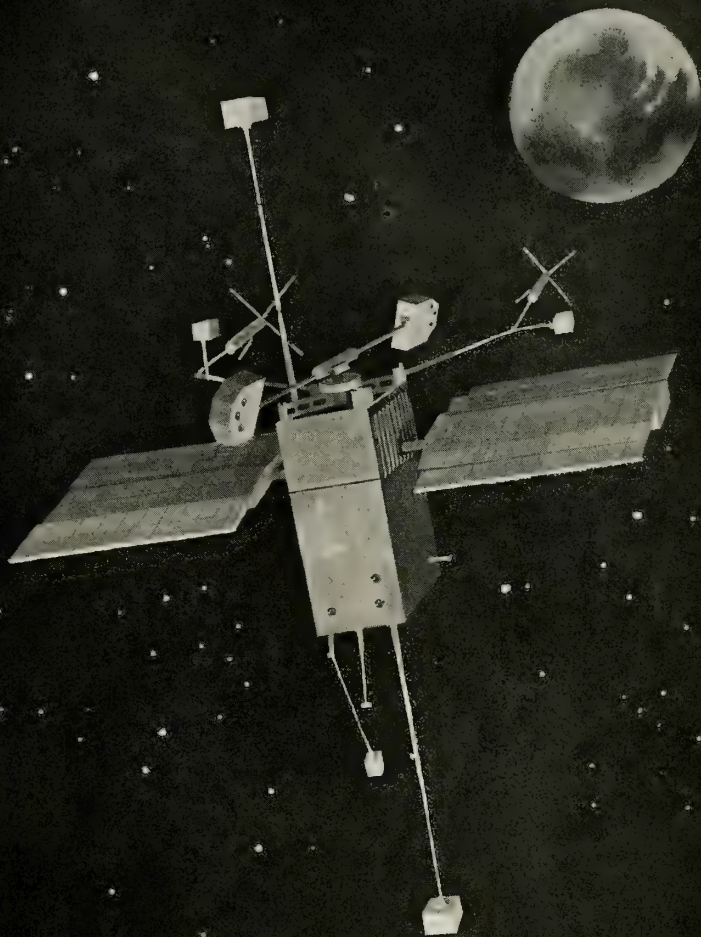
Certain NASA spokesmen say the recently completed "Golovin" study is not the complete answer, and that NASA Administrator Webb is not obligated to buy all of the committee's recommendations.

The committee called for parallel *Nova* development with direct lunar flights in mind, and suggested the funding of the Air Force 120-in.-diameter solid booster.

The Jet Propulsion Laboratory has requirements for chemical-type orbiting retrorockets which will remain in operational condition over a 3- to 6-month time span while traveling to other planets. The facility is reviewing both solids and storable liquids.

JPL has no definite plans, at the moment, as to how and where electrical propulsion systems will be used. Some thought is being directed, however, toward applying such systems to planetary orbit tasks. This is in addition to long-range interplanetary flights.

The lab is also looking at the possibility that *Saturn* may provide some capability for high-energy missions such as flights to Mercury and Jupiter. Details await final choice of the *Saturn* version.



## How OGO keeps its eye on the ball

When OGO\* goes into space carrying as many as 50 scientific experiments for NASA it must maintain proper orientation up to a year in orbits varying from near-earth to cislunar. A new horizon scanner system, an outgrowth of the highly successful scanner used in all Discoverer satellites, is being developed by Advanced Technology Laboratories to provide OGO with vertical reference data. This advanced scanner system continuously monitors the earth's infrared horizon and initiates corrective action as attitude changes are detected.

ATL's system was selected by Space Technology Laboratories, Inc. because

of its unique ability to meet the requirements of high reliability and accuracy, long life, orbital flexibility and minimum size, weight and power.

ATL is also actively engaged in the development and manufacture of other satellite stabilization components and systems, including optical rate/yaw Sensors and micro-thrust reaction control systems. Individuals interested in challenging career opportunities at this "Equal Opportunity Employer" on the San Francisco Peninsula should direct resumes and inquiries to the Personnel Department.

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# Auxiliary Power R&D Funding Up 88%

NASA IS MAKING a concerted effort to develop auxiliary power units (APU's) for long-duration spacecraft.

The big push is for nuclear-electric power systems, particularly *SNAP-8*. But there is also a major drive in the non-nuclear area, as shown in the agency's funding breakdown:

—Nuclear APU R&D is budgeted for \$7.7 million in FY '62—more than double the \$3.5 million spent in FY '61.

—Non-nuclear APU R&D is getting \$5.5 million—a gain of \$2 million over the FY '61 figure.

About \$700,000 is earmarked for fuel-cell work, but none of this money will be spent directly for *Apollo* APU's.

(In its quest for secondary power for *Apollo*, NASA seems convinced that fuel cells are the answer although a final decision has not yet been made. Present auxiliary power requirements for the spacecraft call for a two-week system able to reach a peak power of 3 kw, an average continuous power of 1.5 kw, and re-entry power provided by zinc-silver cells.)

• **Where the business is**—Bits and pieces of NASA's APU work are scattered throughout the agency. But all of it is under the general direction of two men at NASA headquarters: Walter Scott and Fred Schulman.

Scott is responsible for solar and chemical auxiliary power developments. Reporting to the as-yet-unnamed director of propulsion and power generation, he has in his area about 30 contracts with industry.

In general, Jet Propulsion Laboratory monitors the solar thermionic work; Lewis Research Center, the solar mechanical nuclear and fuel cell; Goddard Space Flight Center, the battery work and some radiation damage studies; Langley Research Center, some collector studies; and Marshall Space Flight Center, a small effort (battery-oriented) on auxiliary power for launch vehicles.

Reporting to Harold Finger (Director of Nuclear Systems), Schulman is responsible for nuclear electric power systems. Much of this work is done at Lewis. The Center has under contract about a dozen companies working in R&D areas related to nucleonics: materials, corrosion, advanced components work, etc. Moreover, while the AEC is supplying the reactor for *SNAP-8*, Lewis is supplying the rest of the system.

Prospective R&D contractors interested in contributing to the APU field are urged by NASA to discuss their proposals either with Scott or Schulman, and also with the appropriate

space-agency center.

• **Opportunities at JPL**—JPL is very much interested in thermionic solar-conversion systems as a potential improvement over solar panel-type collectors. The Laboratory has some research contracts out in this area and will have more.

*Voyager*, for example, may be equipped with a thermionic solar-powered conversion system, rather than the photovoltaic solar panels now in use.

The Laboratory is also looking for better power-regulation equipment, which is needed to go either with the solar-thermionic or photovoltaic conversion systems. Right now, these regulation devices have 50% losses. JPL is eager to look at anything practical that can be done to reduce this loss.

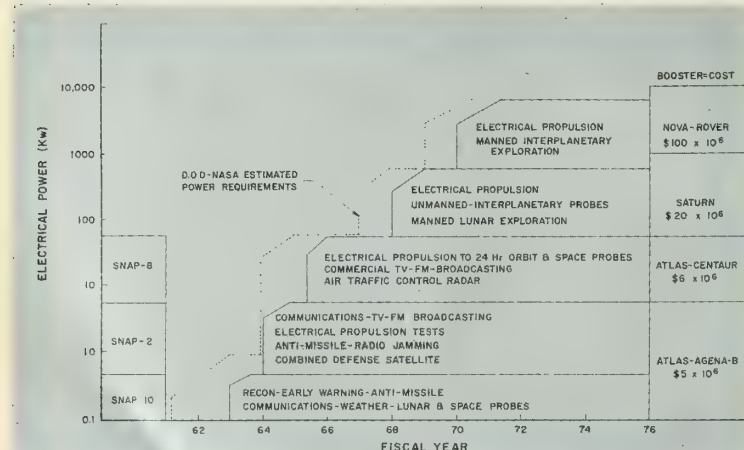
For the planetary program, its director, R. J. Parks, says: "We will be choosing components, subsystems and such principally on what we know about reliability and lifetime capabilities." He emphasized that high reliability and long lifetime are of overriding importance.

Scientists at JPL also made the following observations to MISSILES AND ROCKETS:

Up to 1965, spacecraft power systems may use voltaic cells, primary batteries and static converters and inverters. Beyond that time, when a continuous unregulated power capability of 2500 watts is wanted, photo-voltaic sources probably will not be feasible because of their high cost. Solar or nuclear-powered thermionic or turbine generators appear to be more attractive.

Furthermore, the effort spent developing photovoltaic cells should concentrate on increasing efficiency and reducing cost. With respect to batteries, efforts over the next few years should be directed toward reducing weight and lengthening cell life. Secondary batteries should have better charge-discharge efficiency in order to ease the power requirements for orbiting missions.

(A high source in JPL's lunar exploration program feels that NASA ought to start thinking early—and now is not too early—about a manned moon



Space Power Requirements and First Flight Availability



base. He says serious studies should get under way within the next two years. At the present time, JPL is not doing anything on the moon-base problem.)

Over the next decade, the lunar exploration program will require a "family" of nuclear power sources for operation on the moon's surface. The need is for lower-power sources for transmitters and TV systems, and high-power sources for propulsion on the surface.

• **Opportunities at Lewis**—Lewis is working on fuel cells, *Sunflower* and *SNAP-8*, and invites R&D effort in areas that can support these energy conversion projects. "We are certainly interested in getting industry help . . . Tell them to get in touch with us!" a Lewis project engineer urged M/R.

The Center is monitoring a \$300,000 Pratt & Whitney R&D contract calling for development of a modular fuel-cell system. (Research on an electrical regenerative hydrogen-oxygen fuel cell falls under \$100,000 contract with Electro-Optical Systems, which for geographical reasons is monitored by JPL instead of Lewis.)

Lewis is also monitoring *Sunflower*, which NASA is planning to flight-test in 1966. This is a 3-kw system being developed by the TAPCO Group of Thompson Ramo Wooldridge, consist-

## Space Power Technology Budget

(For contracted R&D—FY '62)

| ADVANCED RESEARCH:                          |                    |
|---------------------------------------------|--------------------|
| Radiation damage                            | \$250,000          |
| Fabrication techniques for solar collectors | 100,000            |
| Space power systems                         | 200,000            |
| Thermionic conversion                       | 300,000            |
| Thermal energy storage materials            | 100,000            |
| Regenerative fuel cells                     | 100,000            |
| Magnetohydrodynamic power generation        | 150,000            |
| <b>Total</b>                                | <b>\$1,200,000</b> |

| ADVANCED TECHNICAL DEVELOPMENT: |                    |
|---------------------------------|--------------------|
| Solar-cell array technology     | \$200,000          |
| Power system components         | 200,000            |
| Improved batteries              | 300,000            |
| <i>Sunflower-1</i>              | 1,800,000          |
| Primary fuel cells              | 500,000            |
| Solar concentrators             | 400,000            |
| Chemical power units            | 300,000            |
| Solar-thermionic power system   | 500,000            |
| Regenerative fuel cells         | 100,000            |
| <b>Total</b>                    | <b>4,300,000</b>   |
| <b>Grand Total</b>              | <b>\$5,500,000</b> |

## Nuclear Electric Power Systems Budget

(For contracted R&D—FY '62)

|                                         |                    |
|-----------------------------------------|--------------------|
| Advanced systems and components         | 2,500,000          |
| Prototype development ( <i>SNAP-8</i> ) | 5,000,000          |
| <b>Total</b>                            | <b>\$7,500,000</b> |

ing of a foldable petal-type solar collector that will open to a diameter of about 32 feet.

The sun's rays will boil liquid mercury which will drive a turbo-generator to product electric power. The thermal-energy storage unit will permit continuous operation, even when the craft is in the earth's atmosphere.

NASA is drawing up plans to develop nuclear power-generation systems able to put out tens of kilowatts. This will be a long step beyond the *SNAP-8* units, which are expected to go into flight-test during the spring of 1965. The flight test will follow ground demonstration and endurance tests that will probably begin in late 1963.

The *SNAP-8* will come in two designs: a 30-kw configuration, with one reactor and one turbine conversion unit; and a 60-kw configuration, still with one reactor, but with two conversion units (M/R, Aug. 22, 1960, p. 39).

Many other types of APU's are being developed both by other government agencies and by industry. Specifically, there are nuclear units other than *SNAP* which may challenge some of NASA's concepts and hardware. Moreover, industry may have in its proprietary or unfunded pouch some developments that could drastically reshape the APU picture. ■

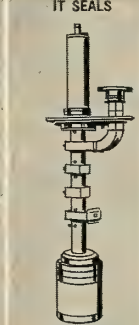
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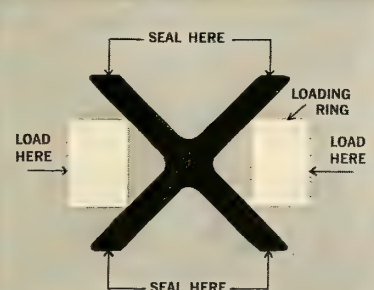
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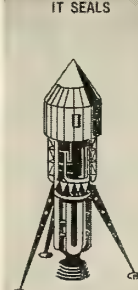


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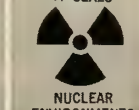
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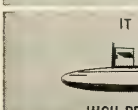
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# Industry Getting More Research Work

*Marshall, Langley and Lewis lead centers in materials studies; large space projects are boosting outside participation*

THE BASIC TREND in NASA materials research and development is toward greater industry participation on a contract level. The whole area supports so many NASA activities and is so highly integrated with individual projects that no single dollar figure is available.

NASA has been operating on about an 86% in-house/14% contractual basis, but there are definite indications that the contracting will grow substantially. This does not mean that the in-house effort will decline. In fact, it will increase on a modest scale.

A significant amount of work in the materials areas is being done outside of NASA's direct control. This is in connection with large project contracts. The dollar amount is large, although the work being accomplished is only a small part of the overall contract.

The greater part of NASA materials research is fundamental in nature. But it is always closely allied to space func-

tions. For instance, one group is probing magnetic fields for metal fabrication. Parts have been welded, swaged, formed and punched with these procedures.

One attractive application is in the area of space repair or fabrication. In some instances, with the proper tools, no unbalanced torque is generated—a boon to an astronaut working in a weightless environment.

The method is part of an overall investigation into the usefulness of energy-storage concepts. These techniques can be applied with only a very low average power requirement—easily supplied by current and near-future space electrical power sources.

Besides fabrication, applications include rendezvous and docking, attitude control and propulsion.

• **At Marshall**—At present, the largest single materials effort is at the Marshall Space Flight Center. Programs are under way in high-tempera-

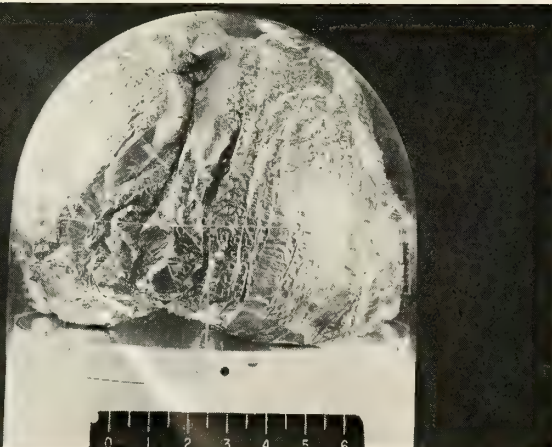
ture pulling of metals, in corrosion, and in cryogenic properties of metals. Marshall's work is usually associated with specific space projects or planned missions.

A graphic illustration is the program to reduce the weight of paint on vehicles. This effort, in one instance shaved 35 lbs. from the *Redstone* booster.

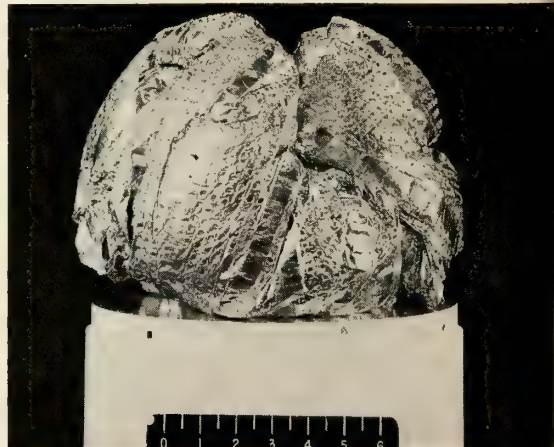
Other major areas cover the vacuum effects on plastic material such as teflon, silicone and rubber. Studies are in progress with solid lubricants (Marshall scientists say no adequate vacuum lubricant exists at the present time). Seals and gaskets are being studied.

A great deal of material evaluation for protective properties at high temperature goes on at Langley. Many promising coatings developed by industry for *Dyna-Soar*-type vehicles are run through series of tests.

Innumerable materials for ablation



EXPANDABLE SPACE STRUCTURES such as this reflector are being actively researched at Langley. Semi-rigid models would



not require constant positive pressure to maintain design configurations. Current studies into radiation-induced memory func-



applications are also checked out at the center. Langley scientists also develop some of their own. Future materials work at the Virginia installation will revolve around planetary vehicles.

The operation is best described as basic applied research. Langley considers structures and materials to be inseparable, and the work illustrates this philosophy. Such efforts center on the fundamental behavior of thin-shell structures—an old field but one that is not satisfactorily understood.

Landing impact absorption is another area. This essentially involves reentry vehicles, but it concerns the last 10 ft. of descent.

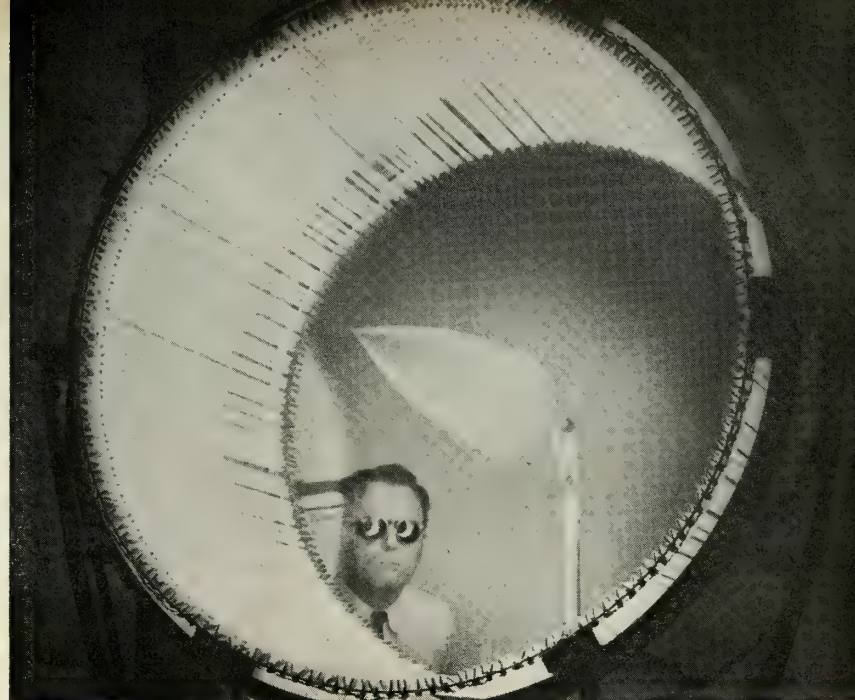
The main limitation is in reproducing the necessary environments—it is sometimes difficult to get temperatures high enough. Langley has started a program in pyrolytic graphite, and some test facilities will have to be slightly modified.

There is concentration on materials for lightly loaded, reusable, manned vehicles, but work is progressing on all types of load-carrying structures. The very light load area is illustrated by the Echo passive communication satellite series.

Echo is a prime example of erectable structures; research into both mechanical and gas erection methods is in progress. In this area there are both in-house and contracted projects involving radiation-induced memory effects on plastics.

Such a development, brought to a successful conclusion, would make possible compact payloads which have "earned" a certain shape. When in space, the payload would "remember" its shape and assume it after a little thermal prompting.

Langley scientists are currently working on Echo II. This 135-ft.-diameter satellite will be more rigidly con-



DATA DERIVED from subjecting a missile nose cone to simulated aerodynamic heating is part of the hypersonic flight information NASA supplies to industry.

structed than Echo I, making it possible to release the erection gas after the satellite has assumed its shape. The polyester film, sandwiched between two layers of aluminum foil, will retain its shape after escape of the balloon gas.

The erection principle is being applied to a number of functional satellites besides passive communications vehicles. Solar concentrators is one fertile area.

The center is also engaged in the effect of both solar and Van Allen radiation on plastics. Hard-vacuum effects on these materials are under investigation.

• **Metal research**—Materials work at Lewis is heavily concentrated on

metals—with the exception of aluminum. Lewis spokesmen say the aluminum industry does all that is needed, but one or two highly specialized projects might be handled by NASA for a specific purpose.

Lewis is largely engaged in long-range work in the areas most closely associated with propulsion—high and low temperatures. There are seldom any specific applications in mind, since most of the research is fundamental. But the group has come up with a promising nickel-based alloy developed by J. Freche.

Molybdenum and tungsten are being alloyed with other materials to increase the crystallization temperature.



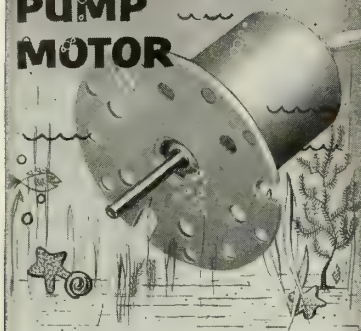
ns in certain structural plastics may completely eliminate the requirement for gas or mechanical erection systems—and



still achieve compact payload capsules. Echo II is now under development at the Langley Center.



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Porous tungsten has been fabricated for ion engine purposes, but this is another instance of deviation from long-range work to help a specific project.

The refractory metal program seems to be mainly applied to tungsten, but with a small effort directed toward columbium. There is also work in inorganics, such as hafnium carbide. A group is researching dispersion hardening in composites. Here the primary task is to get a more refractory precipitation. Aluminum oxide is mechanically inserted in some experiments.

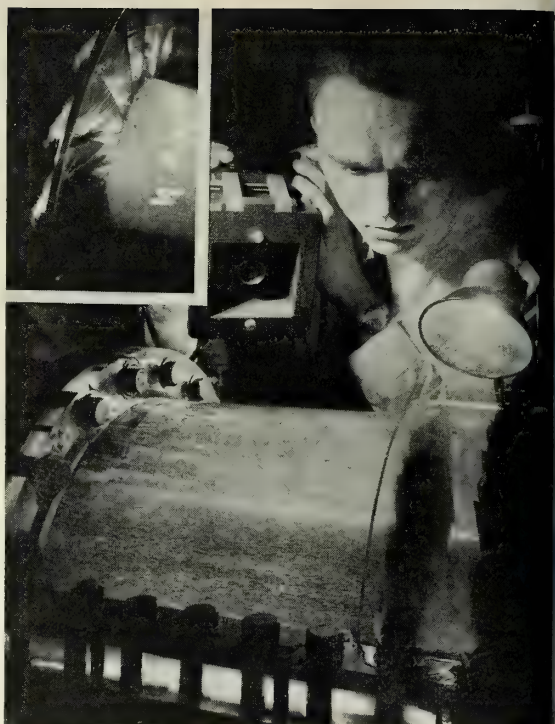
In physical property work, Lewis researchers have developed a simple method to predict fatigue effects through conventional tensile measurement data. The role of imperfections in reducing strength is being actively probed. Much of this work is aimed at obtaining general data for design purposes.

Lewis scientists went deep into compatibility problems in liquid metals systems. Potassium and sodium work has been in progress for over 10 years. There was a brief excursion into mercury and the data gathered was given to industry. NASA then backed out and returned to the K-Na systems.

NASA scientists consider the K-Na area a virgin field and well worth extensive work. Current projects involve small test loops, but materials experts are hoping to get into complete systems. Purity is a huge problem here, and extremely elaborate facilities have been built—for every experiment each bit of apparatus gets more and more complex.

There is a large effort in single crystals. NASA would like to be able to measure impurities down to 0.1-part-per-million. Whisker and fiber metallurgy are under active investigation. Lewis is working in copper impregnated with tungsten fibers. One result of such efforts is the confirmation that strength is not determined by long fibers. Short, disjointed fibers in metal matrixes give the highest strength values.

Tensile and stress rupture experi-



VAPOR FORMATION, damaging to rocket engine pump blade (inset) is included in NASA propulsion research.

ments with tungsten have resulted in facilities that are almost a research job in themselves. Lewis has one of the country's most complete laboratories for high-temperature physical property work in metals.

This center is also engaged in modifying the vacuum chamber area within a large arc furnace. Researchers hope to explore more fully the vacuum-melting technology by keeping all of the work under vacuum. This aspect of metal refining should lead to ingots of purities unheard of in production-type furnaces.

The huge problem of insulating, cryogenic tankage is being attacked at Lewis. Even in the familiar method of using layers of heat-reflecting insulators, there is a problem in arrangement—how close these elements can be to each other is closely related to the wave-length of radiated heat.

The linkage between the layers poses a problem. Anything in the space impedes the formation of a vacuum by blocking outgassing. The outgassing time could easily nullify the insulation.

• **Electrical requirements**—Transport processes within thermionic converters is another important material research area at Lewis. Researchers are trying to lengthen the hot emitter life by introducing chemicals into the gap these react with the material diffusing off the hot surface and then re-deposit.

One group recently completed at





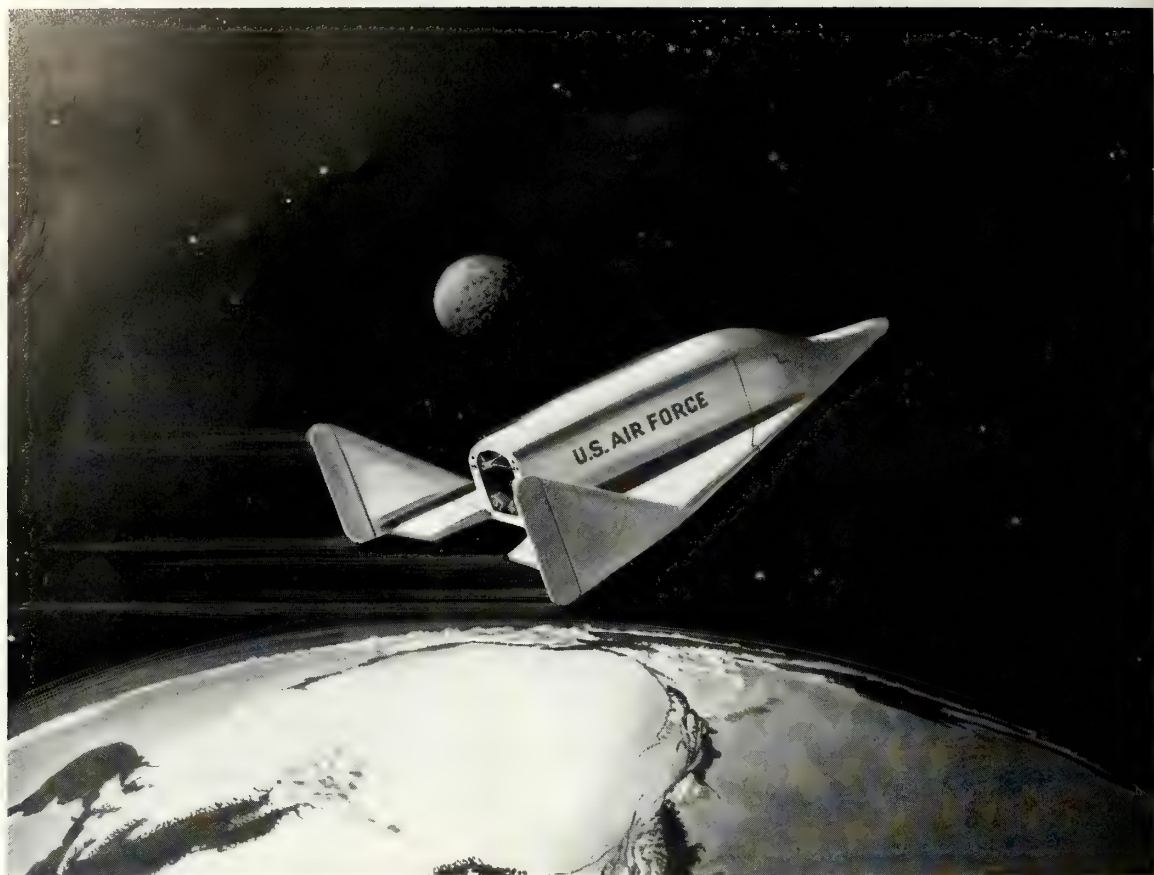
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**SPACE GLIDER.** Drawing of Dyna-Soar space glider, which will combine extreme speed of a ballistic missile with controlled and accurate flight of a manned aircraft. Designed to be rocketed into space, where it could travel at speeds approaching 18,000

mph, Dyna-Soar will be able to re-enter earth's atmosphere and make conventional pilot-controlled landing. Boeing is system contractor for Dyna-Soar, now being developed by U. S. Air Force with cooperation of National Aeronautics and Space Administration.

## *Capability has many faces at Boeing*



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**AUTOMATIC SKY FIGHTER.** Supersonic Boeing Bomarc missile, now operational, is the United States Air Force's push-button defense weapon against airborne missiles and attacking bombers. New Bomarc "B" models have scored test intercepts up to 446 miles from base at altitudes of more than 100,000 feet.

# **BOEING**



analysis of radiant heat transfer by integrating the energy across a spectrum of wave lengths, using machine computation. They found answers 25% different from standard gray-body analyses.

There is some work in high-efficiency, high-temperature compounds such as the tellurides and sulfides. Extremely thin-film solar cells are being investigated. Here thinness is determined by molecular thicknesses. The trick seems to be in picking the correct substrate. Lewis is having some success with MgO.

Another project involves spectrally selective surfaces for heat engines. The objective of the search is a surface which will absorb or emit in one end of the spectrum and not the other. If a sharp separation is achieved, an efficient machine will result.

Some interesting problems are cropping up in the cryogenic tankage field. Lewis scientists are currently bursting small vessels in liquid hydrogen. These experimental setups are in themselves a major research and development effort.

Another group has gone deeply into the micrometeorite effect. They are learning exactly what happens to a vessel full or partially full of liquid by firing high-speed particles into test chambers.

In one particular experiment, a particle was fired through an existing hole into a liquid-filled tank. The hole had been sealed with plastic tape. The liquid easily absorbed the projectile's energy, but the shock wave produced in the liquid shattered the tank.

This secondary effect is being explored; higher-speed projectiles, up to 30,000 fps, are being planned.

NASA has specific need to find proper materials for containing liquid potassium and sodium. Lewis is now screening all commercially available alloys. If none fit the bill, the Center will proceed to develop one.

Materials work at Ames is difficult to separate from the re-entry projects under way at the Center. The vast majority of the materials effort is in evaluation or suitability studies involving re-entry simulation.

Some programs are concerned with the reaction of materials to ion bombardment in space—the erosive effect.

Jet Propulsion Laboratory has no demanding in-house materials work at present. Their major concern is in getting the lunar-planetary programs under way. At present, project directors are reluctant to predict or speculate in this area.

Provisions have been made to construct a materials laboratory at JPL to support the lab's space vehicle development responsibility. #

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## Panel to Decide How 'Bio' Funds Are Spent

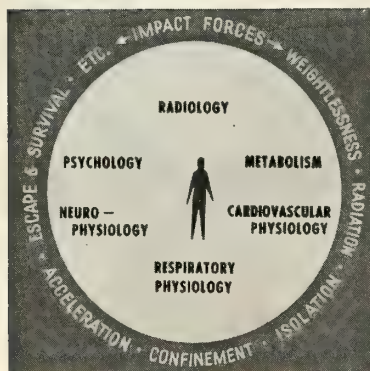


CHART shows need for space medicine investigations by specific categories.

NASA'S SPACE medicine or "bioastronautics" efforts are oriented in two directions. They are under the Office of Aerospace Medicine and the department of Bioscience Programs, in the Office of Space Sciences.

Aerospace Medicine has headquarters at NASA's Washington offices and will have some facilities at the Manned Spaceflight Center at Houston. Bioscience Programs is located at Ames Research Center, Moffett Field, Calif.

However, the entire NASA life sciences operation is now facing one of the most crucial periods in its rather harried existence. A bioastronautics panel, chartered by the National Aeronautics and Space Council, is currently investigating all space medicine facilities, military and civilian, to determine whether duplication exists, precisely what new facilities are needed—and who should build them.

The Bioastronautics Panel is believed to have been initiated because of the many accusations of "wasteful spending" and "empire building" leveled at the NASA office of life sciences since its inception in spring, 1960. Congressional committees have constantly questioned the necessity of constructing new space medicine facilities when the Air Force appears to be so well equipped.

Dr. Edward C. Welsh, NASC executive secretary, has indicated that when the panel, comprised of some 10 educators, reports its findings, a recommendation will be made which will generally determine the future of NASA's space medicine programs.

If the panel finds military installations adequate for space medicine research, as many of NASA's critics in Congress hold, NASA may find its programs limited to the more or less "basic" research for which a capability is rapidly being built at Ames. If the military installations are found lacking, NASA will undoubtedly get a full-steam go-ahead and sole responsibility for the problems of man-in-space, including sole responsibility for all bio-satellite shots of any kind.

• **Budget breakdown**—NASA's original '62 space medicine budget request was for \$8.6 million. The authorization was upped to \$20.6 million upon the Administrations's decision for the manned lunar program. Of this \$20.6 million, \$5.3 million will go to aerospace medicine research and \$4.1 million to advanced technical development in aerospace medicine—all the responsibility of Brig. Gen. Charles H. Roadman.

Space biology, whose chief is yet to be named, has been appropriated \$1.8 million for research and for tech-

nical development. For both programs a fund of \$9.4 million exists for flight experiments.

• **Space biology**—Broad objectives stated for space biology are: 1) study effects of space environment on living organisms, 2) assess organic chemical life-supporting compounds on extra terrestrial sites, 3) develop means of remote identification and analysis of possible extraterrestrial life forms, 4) prevent terrestrial organic, chemical or microbiological contamination of extra terrestrial bodies to preserve them for study of life processes.

The future of the Ames Research Center seems fairly certain. The center is developing considerable in-house capability for biological probes as well as ground simulation facilities. At present there are about 20 of a proposed 100 man technical staff, many of whom were transferred from NASA headquarters. One of these men is employed full time for procurement, indicating expansion potential.

Ames also has budgeted \$5.7 million under construction of facilities. Of this \$800,000 will be used to modify and equip part of the flight operations laboratory for a life science research facility. This operation will enable the life science group to study some of the biological technological aspects of spaceflight and do basic research in space medicine.

• **Ames shopping list**—The center already has a battery of simulators some left over from NACA days. However, it is aiming for a space chamber type simulator which can be used in conjunction with its movement simulators. This might have five degrees of motion in a chamber with heat, pressure, oxygen environment, isolation, and noise controls, etc. Ames has also stated a desire for a device to simulate a 14-day space trip, but in view of the prohibitive costs, it is not likely to be on the shopping list soon.

The Ames group is studying various restraint systems. It has, in fact, designed one for research programs aimed at determining the ability of pilots to perform meaningful control tasks during high accelerations. The Ames group uses the Southern California and Johns ville centrifuges to test these systems. Much of the restraint suit work is done in-house, but some of the work went to industry, such as a helmet which was designed by Protection Inc., of Los Angeles. It is expected that other projects of this type will be forthcoming.

Bioinstrumentation for measuring pilot response during centrifuge tests and weightlessness experiments (in fact all simulation devices) may provide a market for industry devices. Hughes



Aircraft Co., for example, was the recent recipient of a \$75,000 contract for a physiological monitoring system for the X-15.

The biosciences group also plans to develop a primate training facility for laboratory research and experimental flight. Equipment needs may include animal training devices, environmental chambers and life support systems suitable for flight.

NASA also lets contracts for basic research experiments which may have space on space vehicles. An example is the *BIOS 1* shot (Biological Investigations in Outer Space) which carried experiments designed by universities, AEC laboratories and industry. These awards usually are in the form of grants, given to groups with a known or demonstrated capability in a certain type of research.

More and more contracts undoubtedly will be awarded for space capsules to carry biological probes. These probes require intricate electronic devices, timers, actuators, etc., to conduct rather complicated experiments enroute. As an example, General Electric got \$523,000 to modify the *Nerv* capsule for the *BIOS* experiments.

NASA will support work in the

categories of experiments in radiobiology, microbiology, meteorite analysis and extraterrestrial environmental studies.

The technical development authorization is planned to go for decontamination techniques, microbiologic analysis, chemical analysis and instrumentation.

• **Space medicine**—Aerospace medicine's broad objectives are: 1) Finding requirements for integrating the human operator into space systems, 2) perfection of life support systems, 3) determining best methods of giving information to human pilots, 4) protection of man and machine against radiation, 5) biological aspects of communications, 6) remote control, 7) bioinstrumentation and 8) space crew selection and training.

Inflight experiments to support the aerospace medicine program will be concerned with weightlessness, radiation and flight testing of components and medical systems.

The money appropriated for advanced technical development will roughly go to development of radiation protection, protective life support systems, displays, controls, models and simulators for crew selection and training.

NASA aerospace medicine officials have expressed a desire to develop flight vehicles for investigation of space radiation, weightlessness and the search for extraterrestrial life. They wish to perfect a recoverable biosatellite for primate and lower biological systems, and spacecraft laboratories carrying men, which would orbit under the radiation belts to investigate weightlessness. Life support systems and subsystems for these craft will ultimately be necessary.

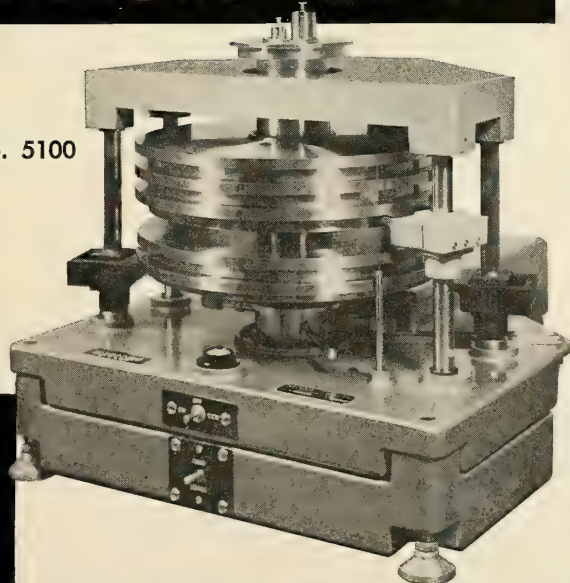
NASA's Manned Spaceflight Facility at Houston will include a section for Aerospace Medicine. This operation, according to officials, will not be involved in basic research for manned spaceflight. Rather, it will be concerned with the development of specific life support systems, space suits, etc., and the selection and crew training for actual flight.

This operation will require many expensive training devices, such as simulators and a centrifuge. Just how much money the facility will actually be given for equipment will depend largely upon the Bioastronautics Panel's findings. *Apollo* astronauts may be forced to travel about the country to use existing military equipment, as did the *Mercury* astronauts, if the Panel decides present facilities will suffice. ■

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# Agency Preparing to Award as Much

*While retaining for the present its established types of contracts, NASA will add procurement personnel, revise procedures, possibly delegate more authority to field centers*

NASA contracting with U.S. industry over the next several years will approach and perhaps surpass \$4 billion annually.

To gear up for this giant procurement effort, the space agency is beefing up its procurement staffs, trying to attract more firms to its industry team, and making some changes in its contracting procedures.

Two things appear certain, however:

—There will be no major changes in the types of contracts awarded by NASA—at least for the next couple of years.

—Advertising for bids which includes asking for industry proposals to bid will continue to outstrip negotiated contracts.

While the main elements of NASA contracting policy will remain the same, the agency is making some innovations and refinements in procedures. These include:

—NASA headquarters may delegate more authority to the field centers, where almost all of the agency's contracting is done. Currently, headquarters must approve all contracts over \$100,000 at all centers except Marshall Space Flight Center. Marshall can award contracts up to \$1 million without approval. This is currently under review. One center—the Manned Spacecraft Center at Houston—is almost certain to get more authority.

—A major effort will be made to insist that firms submit complete, accurate and current cost data during contract negotiations.

—To make better use of DOD audit services at missile/space industry plants, NASA is assigning its own representatives to plants with major NASA contracts, to supply liaison between the contractor and the space agency.

—A review of contracting procedures at field centers is being undertaken by teams of headquarters procurement officers. Its major effort will be to streamline and standardize contracting policies.

—Better reporting systems are being developed. Center procurement offices will be required to submit status reports on all contracts over \$100,000.

• **How it slices**—The estimate of the total size of NASA procurement is based on NASA's experience in Fiscal 1961 and its estimate for the current fiscal year.

Of NASA's total Fiscal '62 budget of \$1.672 billion, some 80%, or \$1.3 billion, will go to U.S. business. Some 56%, or \$750 million, will be awarded in direct contracts to industry.

About 15%, or \$200 million, will go to non-profit corporations including the Jet Propulsion Laboratory; another 29%, or \$389 million, will go to other government agencies. NASA officials said, however, that almost all of the funds going to the non-profits and Federal agencies will—in turn—go to industry in the form of contracts.

With NASA's total budget expected to hit \$5 billion annually in the near future, it is likely that the portion going to industry will approach \$4 billion and will continue at that rate or surpass it for quite a few years.

Firms participating in this giant procurement program will find that NASA has two basic contracts which account for almost all of its procurement.

• **Fixed-price contract**—This is used most frequently and is preferred for procurement of goods and services that can be clearly described. This type of contract can be used for either formally advertised bids or for negotiated procurement. There are also occasions when a fixed-price or "lump sum" contract may be employed to support research.

In arranging a fixed-price contract, provision may be made for special situations. As an example, it could be used for price redetermination when the performance of the contract may involve large contingencies or uncertainties in cost, such as first-time production runs.

• **Cost-type contract**—This usually involves the payment of the total costs of the project plus a certain fixed fee. While fixed-price contracts are the most frequent, the cost type of contract accounts for a larger dollar share of NASA's total procurement.

This type of contract is used when there are a number of unknowns in a program, as in research and development. For example, NASA may use a cost-type contract to support either basic or applied research which has a fixed objective and a deadline for completion. A cost-type contract would—in such circumstances—protect a firm from assuming unwarranted financial risks due to technical uncertainties. Compensation for taking on this type of work could be either straight reimbursement or reimbursement plus an agreed upon "fixed fee." The law prohibits any government agency from entering into any contract which calls for reimbursement of cost plus a percentage of cost.

NASA would very much like to place greater emphasis on the cost-plus-incentive-fee contract, but this is out for the next couple of years. The agency recently conducted an in-house review of this concept, but its procurement officials have decided that implementation to any great degree is impossible at this time.

The big problem in this area is that a lot of "cost experience" is required in order to assess contract performance on which the incentive fee is based. Because most of NASA contracting in the R&D field involves state-of-the-art advances, use of the incentive fee would create real difficulties in contract negotiations and administration.

• **Procedures**—Firms wishing to do business with NASA should be aware of the following documents:

—*Selling to NASA*—published by NASA headquarters, this booklet includes a complete rundown on contracting procedures.

—*Standard Form 129*—This form



# as \$4 Billion Annually

must be filled out before most manufacturing firms can be placed on the bidders list to which all "proposals to bid" are sent.

—**Form 1071**—This form is for the use of architectural and engineering firms and also puts these firms on the contract bidders mailing list.

Firm included on the bidder lists receive invitations to bid which include technical specifications, delivery or completion dates, place and methods of delivery, the nature and number of reports or manuals which may be required, and other items which should be considered in submitting a bid.

Firms do not have to wait for NASA to make a formal request for an R&D proposal. There is no specific form for unsolicited proposals, but some of

the information which it should contain includes:

—Name and address of the organization.

—Number of employees, including totals and qualifications for technical personnel.

—Brief description of facilities, outline of previous work, and a brochure and financial statement, if available.

—Title of proposed research and the name of the principal investigator.

—A brief abstract of the proposed project and a suggestion as to starting and completion dates.

—An outline of the proposed budget and costs.

• **For small business**—NASA also has a program designed to increase opportunities for small business firms to

take part in U.S. space program.

Most of these opportunities lie in subcontracting work with NASA's prime contractors.

To insure that small business firms are being given an equal opportunity to share in the space business, NASA requires that all prime contractors and all subcontractors with awards over \$1 million participate in the program.

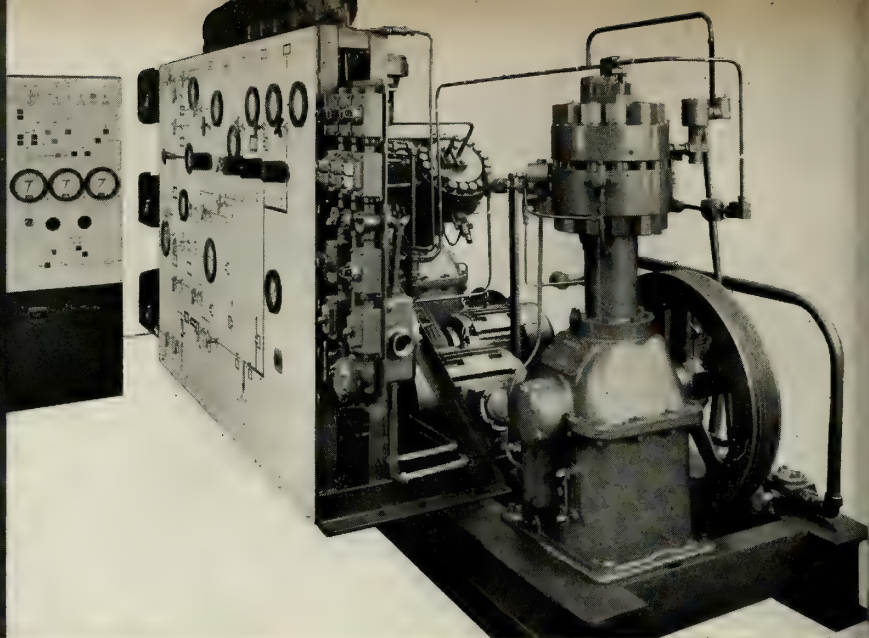
It requires that these firms appoint a small business liaison officer who must work with officials of both the Small Business Administration and NASA.

The liaison man must set up a program to insure that small companies have an opportunity to compete with big firms, and he must keep records and report how much of the work is going to small firms. ❖

## Directory of NASA Procurement Organization

| Center                        | Address               | Contracting Areas                                                                                                                               | Procurement Chief            | Small Business Advisor |
|-------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------|
| <b>NASA Headquarters</b>      | Washington 25, D.C.   | Overall Management and Administration of Agency Contracting Procedures                                                                          | Ernest W. Brackett, Director | Jacob M. Roey          |
| <b>Headquarters</b>           |                       |                                                                                                                                                 |                              |                        |
| Procurement Branch            | Washington 25, D.C.   | R&D Study Contracts Supplies                                                                                                                    | Alebrt A. Claggett           | None                   |
| Ames                          | Moffett Field, Calif. | Life Sciences—Simulation Electronics and Electrical Devices                                                                                     | A. S. Hertzog                | Donald E. Davis        |
| Langley                       | Langley Field, Va.    | Electronics, Optics, Simulation                                                                                                                 | Sherwood L. Butler           | Joseph F. Braig        |
| Goddard                       | Greenbelt, Md.        | Spacecraft, Scientific Instrumentation, Batteries, Tracking and Computing Equipment, Environmental Chambers—Battery R&D, Data Handling Services | Gordon H. Tyler              | Harry T. O'Toole       |
| Jet Propulsion Lab.           | Pasadena, Calif.      | Scientific Instrumentation, Spacecraft Tracking                                                                                                 | Ted Candee                   | D. W. Anawald          |
| Western Operations            | Santa Monica, Calif.  | Manager and Monitor Contracts For West Coast NASA Installations                                                                                 | Earle Sample                 | Paul E. Ross           |
| Flight Research               | Edwards, Calif.       | Only Small Procurement in Support of X-15 and Apollo Re-entry Research                                                                          | Morris E. Bowling            | Lloyd J. Walsh         |
| Wallops                       | Wallops Island, Va.   | Electronics Subsystems and Range Services                                                                                                       | Louis T. Birch               | Joseph Robbins         |
| Marshall                      | Huntsville, Ala.      | Saturn & Centaur Procurement, RIFT, J-2 Upper Stage                                                                                             | Wilbur S. Davis              | Wm. C. Sayre           |
| Lewis                         | Cleveland, Ohio       | Electrical Propulsion and Apollo Spacecraft Propulsion Segments                                                                                 | John Biggs                   | Norman C. Prahst       |
| Launch Operations Directorate | Titusville, Fla.      | GSE, Electrical Components, Cryogenics                                                                                                          | Gerard A. Michaud            | None                   |
| Manned Spacecraft Center      | Houston, Tex.         | Spacecraft, Electronics, Life Sciences, Instrumentation                                                                                         | David W. Lang, Jr.           | Harold Christian       |
| Space Nuclear Propulsion Off. | Germantown, Md.       | Nuclear Propulsion                                                                                                                              | L. C. Corrington             | None                   |

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Illustrated above is a shock tube pressurization system recently constructed by Aminco for a major aircraft company. The system is designed for pressurization of a large 15,000 p.s.i. system. It includes three Corblin diaphragm-type compressors (two shown); manual and automatic controls for pressurization and firing of the shock tube; a medium-pressure gas-mixing vessel (not shown); and a high-pressure gas-storage vessel (not shown).

In operation, either a helium-hydrogen mixture may be taken from the gas mixing vessel at elevated pressure for further pressurization, or air may be taken at atmospheric pressure for pressurization.

Gas is pumped at 9,000 p.s.i. into the high pressure storage vessel whose volume is about double that of the shock tube driver section. Suction is taken from the high pressure storage vessel, by two high-pressure booster compressors, for pressurization of the driver section. Pressurization can be accomplished within 11 minutes to 15,000 p.s.i.

A remote control panel is provided for filling the driver section with oxygen; pressurization of the driver section; and firing the shock tube.

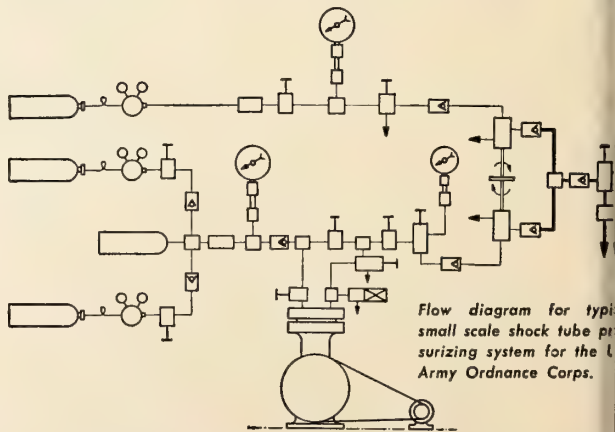
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Flow diagram for typical small scale shock tube pressurizing system for the U.S. Army Ordnance Corps.

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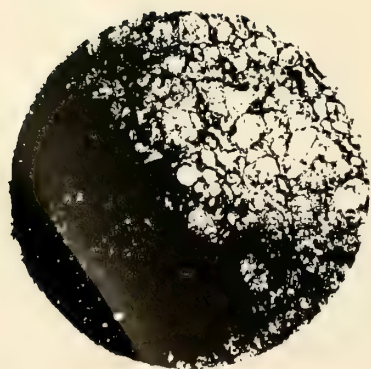
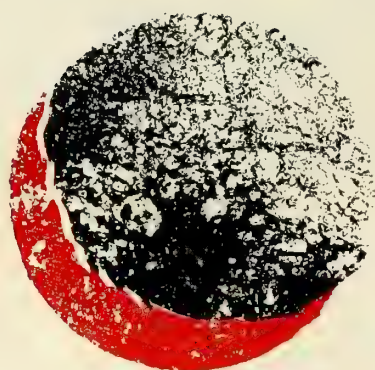
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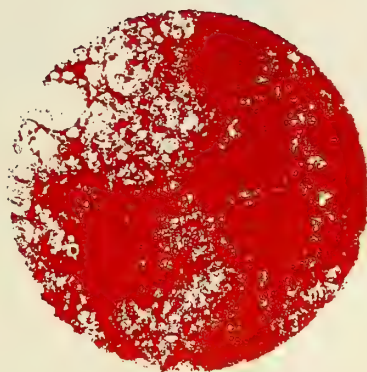
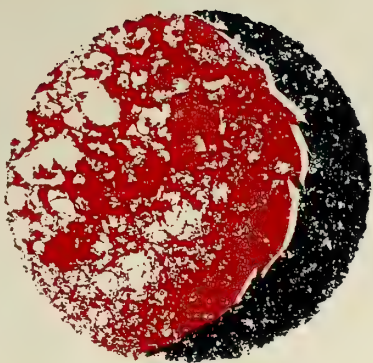
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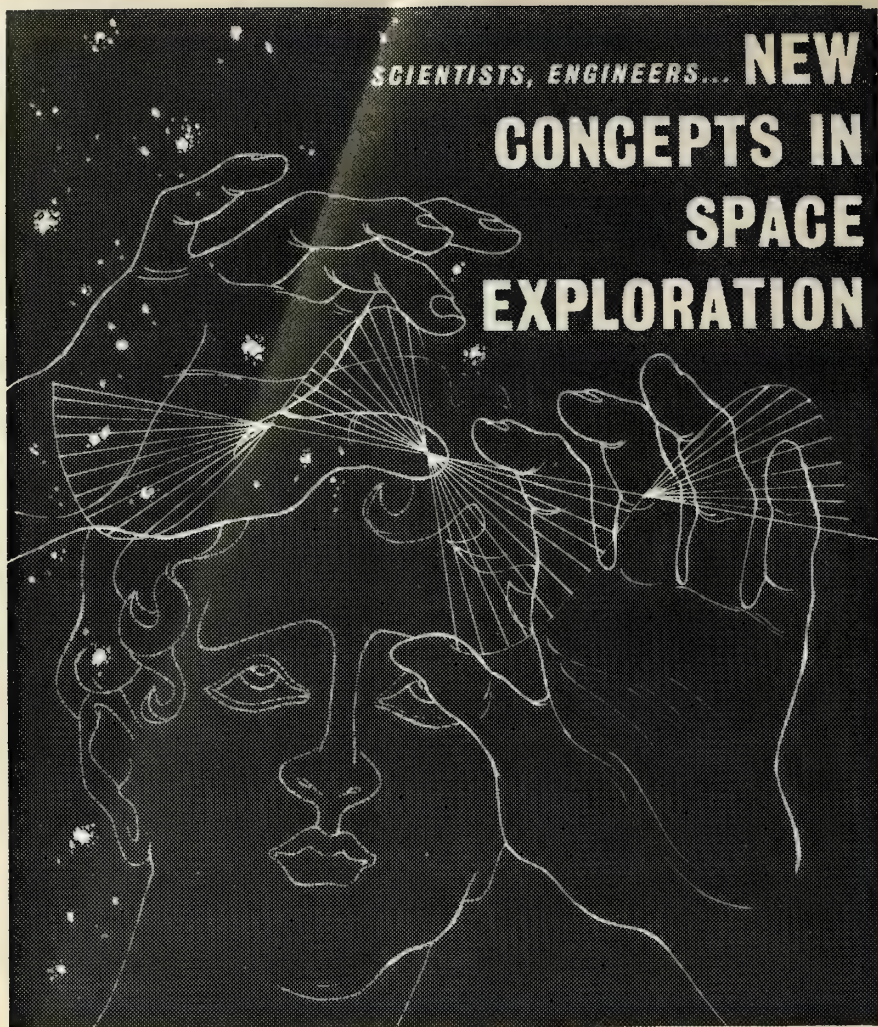
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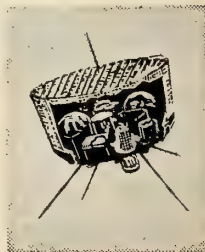


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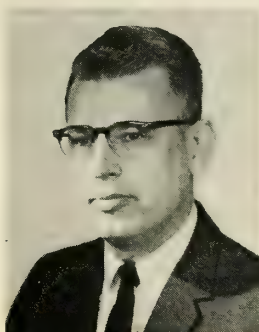
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# Seamans Runs 24,000-Man Lunar Team



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## *Apollo's Key Strategists Are Now Welding Together Vast Government-Industry Complex*

NASA's management team for the *Apollo* program will utilize the skills of some 24,000 individuals under the direction of one man—Associate Administrator Robert C. Seamans, Jr.

He will give final approval for funding of the program, launch schedules and firing dates, program objectives and its completion date.

Other important members of the space agency's new management concept will be the directors of the four major program offices in headquarters and the directors of NASA's various field centers.

The program directors will determine the resource and funding needs of their programs and lay work on the centers. The directors of the field installations will have direct access to Dr. Seamans and will be involved in future policy and program planning.

For the *Apollo* program, primary roles will be played by the Marshall Flight Center, for launch vehicle development, and the Manned Spacecraft Center, for the *Apollo* spacecraft. Overall management control will be in the hands of D. Brainerd Holmes, director of the Office of Manned Space Flight Programs.

NASA officials estimate that the *Apollo* program will consume well over one half of all the space agency's ap-

propriated funds through 1970. About 90% of this will be split about equally between Marshall and Houston.

The remainder will pay the costs of supporting missions at almost all other NASA centers—with main emphasis on the Jet Propulsion Laboratory, Ames Research Center, Lewis Research Center, Langley Research Center, Goddard Space Flight Center and Edwards Flight Research Center.

• **Final lineup**—Final details of NASA's beef-up and reorganization to gird for the long road to the manned lunar landing were released recently as the space agency moved closer to major contract awards for both the spacecraft and its launch vehicle.

Dr. Seamans will serve as its general manager and as arbiter of major disagreements between his management chief, Holmes, and the heads of the various field centers.

He will make the final decision in any matter involving a change in funding or schedule for the program. He will also serve in the same capacity for programs falling under the other three major NASA program offices—Applications, Advanced Research and Technology, and Space Sciences.

He will have as his chief assistants Deputy Associate Administrator Thomas F. Dixon, D. D. Wyatt, Direc-

tor of the Office of Programs, and Albert P. Siepert, director of the Office of Administration.

The latter will deal with financial reports, contracting and administrative services. Wyatt's office will be responsible for coordinating the budget requests of the centers and the various program offices.

• **PERT plus PDP**—To keep track of the program and to channel information from contractors and the field centers to NASA headquarters, the space agency is incorporating two management control techniques—Program Evaluation and Review Techniques (PERT) and the Project Development Plan.

The PDP will be prepared by the director of the field center having major responsibility in the program. It will include program justification, history, scheduling, organization and estimates of needed management, technical resources, funding, and organization.

These will then be sent to the appropriate headquarters program office to be evaluated, revised and endorsed for Dr. Seamans' approval.

PERT—the computer management technique—will be used to keep track of the program, insuring that there are no bottlenecks and that its schedule will be met.

## Estimated NASA Fiscal 1962 Employment Total

|                                    | Approved<br>Complement<br>6/30/62 | Current<br>on-board<br>10/15/61 | New<br>Positions |
|------------------------------------|-----------------------------------|---------------------------------|------------------|
| Headquarters                       | 1,403                             | 805                             | 598              |
| Langley                            | 3,628                             | 3,366                           | 262              |
| Ames (including Life Sciences)     | 1,675                             | 1,513                           | 162              |
| Lewis                              | 3,608                             | 2,891                           | 717              |
| Edwards Flight Research Center     | 494                               | 468                             | 26               |
| Goddard                            | 2,360                             | 1,672                           | 638              |
| Manned Spacecraft Center (Houston) | 1,640                             | 981                             | 659              |
| Wallops                            | 399                               | 364                             | 35               |
| • Marshall                         | 6,490                             | 5,734                           | 756              |
| Western Operations Office          | 119                               | 70                              | 49               |
| Nuclear Office, Cleveland          | 28                                | 16                              | 12               |
| <b>Agency Total*</b>               | <b>21,844</b>                     | <b>17,880</b>                   | <b>3,914</b>     |

\* Includes Cape Canaveral and Pacific Missile Range Personnel.

• Does not include Jet Propulsion Laboratory Total.

PERT is now being used on the *Nimbus* meteorological satellite and the *Syncom* communications satellite programs. It will not, however, be completely implemented in the NASA operation for another year.

Both tools will be used by Holmes, who will be in direct management control of the *Apollo* program. While many of the top decisions will have to be approved by Seamans, the associate administrator declares that "he (Holmes) will be given all the authority to get the job done."

In his job as Director of the Office of Manned Space Flight, he will recommend to Seamans:

- The programs needed to achieve a manned lunar landing.

- Needed action on Project Development Plans prepared by the Centers.

- Estimates of funds required for the *Apollo* program.

- Advanced research and technical development activities which are needed.

In his relations with the Centers, he will:

- Establish and issue instructions in the technical execution of approved projects.

- Authorize the spending of all program-related funds.

- Review and approve basic changes in schedule and reprogram resources.

If budget limitations or schedule dates are affected, final approval must come from Seamans.

- Resolve technical and management disputes between centers.

He will also evaluate the program and project progress and make interpretative status reports of any deficiencies and recommendations for corrective action to Seamans.

- **Joint policy-making**—The directors of the field centers will also play an important role in policy formulation. For the *Apollo* program, this will accrue to Dr. Wernher von Braun at Marshall and Robert R. Gilruth at the

Manned Spacecraft Center.

They will take part in both short- and long-range program planning. NASA is presently considering ways of best implementing the new policy. One idea would bring directors of all of the centers to Washington or a central location for regular—perhaps monthly—meetings with the headquarters program directors. Another would involve regular meetings between the program and center directors involved in a specific program.

The heads of the centers will also report directly to Seamans on their budget and personnel requirements.

In cases where they feel that missions and work laid on the center by the program director would overtax its facilities, they will have the right to appeal to Seamans. These appeals will not be encouraged by Seamans, however, and will be permitted only under exceptional situations.

To speed the flow of information from the field centers to headquarters, the following reports will be required:

- The Project Status Report—requirements for this will be set by each headquarters program office.

- Project Management Reports (bi-weekly).

- PERT Report—Required bi-weekly for inputs into the space agency's overall program control setup.

- Contractor Financial Report—Contractors will be required to report costs, manpower costs, or all systems and subsystems. This will be used by both program and center director.

- Procurement Status Report—Milestones in each procurement action will have to be set and reports of progress toward them made to headquarters.

- Procurement Action Report—All new contract obligations over \$25,000 will be reported to headquarters.

## Major NASA Spacecraft and Satellite Programs

**MERCURY** (Houston) First manned orbital shot early '62; first U.S. manned satellite program. Three-orbit mission.

**MERCURY IIA** (Houston) First flight late '62 or early '63; Mercury with 18-orbit missions.

**MERCURY IIB** (Houston) No schedule to date; proposed program for two-man capsule capable of two-week orbits.

**APOLLO SPACECRAFT** (Houston) Boilerplate launching '63; earth orbit '64-'65; lunar landing '67.

**TIROS** (Goddard) First launching April, '60; second, Nov. '60; third, July '61. Weather satellite with TV cameras and IR scanner. Four more flights planned.

**NIMBUS** (Goddard) First launch late '62; second-generation, earth-stabilized, polar-orbiting weather satellite. Four launches planned.

**AEROS** (Goddard) First flight '65-'66; synchronous orbiting weather satellite.

**ECHO** (Goddard) First launching '60; second, '62; passive communications satellite, rigid sphere.

**REBOUND** (Goddard) First flights late '63-'64; passive communications satellite similar to ECHO; three-six planned.

**RELAY** (Goddard) First flight '62; active repeater communications satellites; similar programs under R&D by AT&T (TELESTAR) and the Army (ADVENT).

**SYNCOM** (Goddard) First flight late '62; 24-hour instantaneous repeater satellite.

**RANGER** (JPL) First flight Aug. '61 failed; second late this year; first lunar landing mid-'62. Instrumented capsule to be rough-landed on moon; early flights in earth orbit.

**SURVEYOR** (JPL) First lunar flight '63; designed for soft-landing on moon with 100-300 lbs. of instruments.

**PROSPECTOR** (JPL) No schedule to date; remote-control, soft-landed lunar exploration vehicle; may be tied to Manned Lunar Landing Program.

**MARINER/VOYAGER** (JPL) Venus fly-by Aug. '62; Unmanned spacecraft for early planetary exploration.

**ORBITING ASTRONOMICAL OBSERVATORY-OAO** (Goddard) First flight late '63-early '64; 3500-lb. "streetcar" satellite equipped with telescope.

**ORBITING GEOPHYSICAL OBSERVATORY-OGO** (Goddard) First flight '67. 1000-lb. satellite with instruments for geophysical measurements; polar orbiter called POGO; eccentric-orbiter, EGO.

**ORBITING SOLAR OBSERVATORY-OSO** (Goddard) First flight late this year; second, '62; satellite for observation of sun and solar atmosphere.





MARSHALL CHIEF Wernher von Braun, with members of his "team," maps expansion schedules.

## NASA INDUSTRY GUIDE

# Marshall to Get \$1 Billion in '63

THE HISTORIC Marshall Space Flight Center—largest and richest of NASA's centers—is undergoing a new explosion of growth in personnel, facilities and pocketbook.

The sprawling research center at Huntsville, Ala., which in its days as an Army installation hurled America's first satellite around the earth, looks today like an overnight boomtown.

New facilities and additions to old ones are going up in almost every direction a visitor looks in the welter of buildings spread out on the flat, red Alabama clay.

The center's original 1200 acres have been extended by another 120 to make room at its heart for a new \$4-million Central Laboratory and Headquarters Building. Meantime, temporary office space has been rented in various nearby buildings including two former motels and a restaurant.

The Marshall Procurement Office, currently letting contracts at a total rate of about \$600 million a year, is operating out of the former Twickenham Hotel in downtown Huntsville. The hotel's former registration desk is manned by a uniformed security guard.

Marshall's role as the NASA center responsible for the development, production and launching of large space boosters and their upper stages has assured it a pivotal place in the Manned Lunar Landing Program.

• **Wealth of programs**—The center—under the direction of Dr. Wern-

her von Braun, and still for the most part his famed "team"—is currently in charge of programs for boosters and upper stages ranging from the *Nova* and the *F-1* and the *Saturn* to the 15,000-lb.-thrust RL-10A-3.

Among Marshall's other programs are *Centaur*, the 200,000-pound-thrust *J-2*, the *RIFT* nuclear rocket, the design of ground support equipment, electric propulsion, and advanced liquid- and solid-propellant technology.

To support these operations, Marshall received \$756.7 million for FY '62—nearly double its budget for FY '61. And the new FY '63 budget for the center is expected to rise to about \$1 billion—nearly a third of the budget for all of NASA.

Nor is this anywhere near a peak. Within the next several years, the Marshall budget is expected to more than double again. NASA officials currently estimate that about 50% of all funding for the Manned Lunar Landing Program will be funneled through Marshall.

The general breakdown on where Marshall is spending its money in the current fiscal year: \$562.7 million for R&D, \$123.4 million for construction of facilities at Marshall and around the country and \$70.5 million for salaries and expenses.

Some of the increases in FY '63 will be spent for additional personnel and facilities, but the bulk is expected to be applied under the R&D account. One of the major new items to be added

to R&D spending will be the production of *Saturn* boosters at the newly acquired Michoud Arsenal in Louisiana.

Marshall plans to let contracts before the end of the year for production of both the *Saturn S-1* and *S-1B* at the \$50-million Michoud plant. These production programs are expected to run to a total of more than \$2 billion.

An interesting sidelight to the Michoud operation is the current heavy competition for the plant housekeeping contract. More than 40 bidders, including a number of major missile/space corporations, are fighting for it.

Another new major addition to Marshall's procurement operations within the next few months will be the *RIFT* program.

• **R&D slices**—During the current fiscal year, the bulk of Marshall's R&D budget is for *Saturn*, *Nova*, *Centaur* and the general liquid-propulsion program, which is mainly the *F-1* and *J-2* engines.

Here is the breakdown:

*Saturn*—\$224.1 million (including \$3 million for the RL-10 engine, \$3 million for *J-2* flight hardware and \$13.3 million for GSE).

*Nova*—\$48.5 million (including \$40 million for vehicle development, \$6.5 million for engine development and \$2 million for system support). This funding is subject to sharp adjustment in

(Text continues on page 91. On page 88 is a Marshall organizational chart.)

W. VON BRAUN  
J. C. McCALL

**DEPUTY DIRECTOR FOR ADM.**  
DEP. DIR. FOR ADM. H. H. GORMAN  
ACTING ASSOC. DEP. DIR. D. H. NEVILL

INDUSTRIAL REL. OFF. P. STYLES

1000

| TECHNICAL SERVICES OFFICE |                |
|---------------------------|----------------|
| ACTING CHIEF              | C. W. HUTH     |
| DEP. CHIEF                | M. I. KENT     |
| SAFETY OFFICE             | L. L. ROBERTS  |
| ENGINEERING BR.           | H. C. ADEN     |
| MAINTENANCE BR.           | D. E. FOXWORTH |
| OPERATIONS BR.            | H. F. McMILLAN |
| PHOTO BR.                 | S. H. HOBBS    |
| PROGRAMS BR.              | J. R. LADA     |
| TECH. MATERIALS BR.       | W. E. BECK     |

ACTING CHIEF  
MGT. ENGINEERING BR.  
ACTING MGT. ANALYSIS BR

SUPERVISOR

LUNAR PLANNING  
PROGRAM OFFICE

**DIRECTOR** H. H. MAUS

P. DIRECTOR F. L. WILLIAMS

**ACTING CHIEF**  
**PLANS & PROGRAMS BR.**  
**SPECIAL STUDIES, SCHEDULES**  
**& PERFORMANCE ANALY. BR.**

## COMPUTATION DIVISION

**DIRECTOR**  
DEP PROGRAM COORD & ADM. OFF.  
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AEROPHYSICS & ASTROPHYSICS  
BRANCH  
DYNAMICS ANALY. BR.  
EXP AERODYNAMICS BR  
FLIGHT EVALUATION BR.  
FUTURE PROJECTS BR

DIRECTOR  
DEP. DIRECTOR  
PROG. COORD. & ADM. OFF.  
AUTOMATIC DATA PROC. SYS.  
BRANCH  
DATA REDUCTION BR.  
FLIGHT SIMULATION BR.  
SPECIAL PROJECTS BR.

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DEP. DIRECTOR  
ADM. OFF.  
PROGRAM COOR.  
ADVANCED STUD.  
APPLIED RESEA.  
ELECT. SYS. INT.  
ELECT-MECH. EN.  
FLIGHT DYNAMI.  
GYRO. & STABIL.  
INSTRUMENTATI.  
NAVIGATION BR.  
PILOT MANE I.

|                           |                 |
|---------------------------|-----------------|
| ACTING DIRECTOR           | W. R. KUERS     |
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| TECH. PROGRAM COORD. OFF. | S. HEIM         |
| ASSEMBLY ENG. BR.         | M. E. NOWAK     |
| ELECT-MECH. ENG. BR.      | R. PAETZ        |
| FAB. ENG. BR.             | O. K. EISENHART |
| METHODS R. & D. BR.       | W. A. WILSON    |
| PLANT ENG. & OPNS. BR.    | W. R. POTTER    |

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**DEP. DIRECTOR** G. B. HELLER  
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**RESEARCH SURVEY & REQ. OFF.** C. G. MILES, JR.  
**NUCLEAR & ION PHYSICS BR.** R. D. SWELTON  
**PHYSICS & ASTROPHYSICS BR.** C. A. LUNDQUIST  
**SPACE THERMODYNAMICS BR.** G. B. HELLER  
**SYSTEMS & INSTRUMENTATION BR.** A. W. THOMPSON

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|----------------------------|----------------|
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| DEP. DIRECTOR AND          |                |
| DIRECTOR FOR PROPULSION    | H. WEINER      |
| ASST. TO THE DIRECTOR      | E. HELLERBRAND |
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| ENGINE MANAGEMENT OFFICE   | L. BELEV       |
| ADMINISTRATIVE OFF.        | A. T. FLYNN    |
| PROGRAM COORD. OFF.        | C. J. RIEGER   |
| ENG. MATERIALS BR.         | W. R. LUCAS    |
| FUTURE PROJECTS DESIGN BR. | W. B. SCHRAMM  |
| PROPULSION AND MECH. BR.   | H. G. PAUL     |
| STRUCTURES BR.             | G. A. KROLL    |
| VEHICLE SYS. ENG. BR.      | H. R. PALAORO  |

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| DEP. DIRECTOR              | R. E. GODFREY  |
| OPERATIONS OFFICE          | T. G. BEDELL   |
| ADMINISTRATIVE OFFICER     | G. M. PETTUS   |
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| MECHANICAL SYS. ANALY. BR. | A. URBANSKI    |
| PERFORMANCE TEST BR.       | C. O. BROOKS   |
| QUALITY ENG. BR.           | S. E. SMITH    |

## TEST DIVISION

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|------------------------------------|------------------|
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| DEP. DIRECTOR                      | B. R. TESSMANN   |
| ADMINISTRATIVE OFF.                | W. H. DODD       |
| ADVANCED FACILITIES PLANNING OFF.  | J. B. CARRINGTON |
| PROGRAM COORD. OFF.                | T. E. EDWARDS    |
| COMPONENTS TEST BR.                | B. R. TESSMANN   |
| MEASURING, SYS. ENG. BR.           | H. F. AUER       |
| ELECTRIC & INSTRUMENTATION BR.     | W. H. SIEBER     |
| SYSTEMS TEST BR.                   | D. H. DRISCOLL   |
| TEST FACILITY DESIGN & SERVICE BR. | F. KRAMER        |

## MICHAUD

**OPERATIONS**  
**MANAGER G. N. CONSTAN**

## LAUNCH OPERATIONS DIRECTORATE

|                         |                  |
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| DEP. DIRECTOR           | H. F. GRUENE     |
| ASST. DIR. FOR INSTRUM. | K. SENDER        |
| ASST. DIR. FOR FAC.     | A. ZEILER        |
| ASST. DIR. FOR OPNS.    | C. C. PARKER     |
| LAUNCH FACILITIES OFF   | T. POPPEL        |
| NASA TEST SUPPORT AMR   | COL. H. B. GIBBS |
| NASA TEST SUPPORT PMR   | CMR. BURTSCHHELL |
| OFF. OF FLIGHT MISSIONS |                  |
| INFORMATION OR SERVICES | J. W. ROSENBERRY |



...or  
inflating  
a rubberized  
flotation  
bag

**FLEXIBILITY** of McCormick-Selph explosive ordnance products is exemplified in the COOL GAS GENERATOR (at left). Greater compactness, lighter weight and ease of storage provide many inflatable bag system applications for: flotation, jacking, ejection, gas supported structures, forming; as well as potential applications such as power supplies for driving turbines, gas motors, pistons, fluids; pressurization of fuel tanks.

**GREATER SAFETY** of McCormick-Selph units is demonstrated in the XBS Modular Exploding Bridgewire System (at right). Developed in conjunction with the Industrial Products Div. of ITT, the system eliminates the use of sensitive primary explosives, and as a result is insensitive to all ordinary physical and electrical shocks, including RF energy, that could cause inadvertent firing.

## EXPLOSIVE ORDNANCE

to ignite to detonate to actuate to eject to open to close to pull to push to inflate to stabilize to release to start to stop

**VERSATILITY** is a maxim at McCormick-Selph. A typical by-product of this versatility in research, design, and production is the welded seal M-100 all-purpose, STAINLESS STEEL PRESSURE CARTRIDGE (at left). Its versatility is not only its environmental compatibility characteristics, but its multi-use applications. This unit develops 200 psi (in a 10 cc chamber) in 5 milliseconds—sustains 1000 psi for 1 second to do a myriad of functions.

**RELIABILITY** of McCormick-Selph explosive ordnance components is illustrated in the EXPLODING BOLT (at right). From the first ceramic-to-metal, sealed, screw-in ordnance power cartridge—through 10 years of production of hundreds of varieties of fragmenting and non-fragmenting bolts—McCormick-Selph has developed the experience and quality control methods so essential to the reproducibility demanded in explosive ordnance.

# MCCORMICK SELPH

### RELIABILITY • GREATER SAFETY • FLEXIBILITY • VERSATILITY

These are the "products" of McCormick-Selph. And have been for the past 10 years in every phase of research, development, testing and production. Whether it's a relatively standard exploding bolt required in large quantities—a complex gas generator (hot or cool)—an all-purpose squib—or a specially-designed exploding bridgewire/system (XBS) such as is now being developed for use in a major Army missile—or any one of the 600 different explosive ordnance devices manufactured by McCormick-Selph—Experienced Engineers—Precision Manufacturing—and Quality Control Performance are the ingredients used to effectively control explosive energy at McCormick-Selph.

Use the tear-out information card at right to find out more about our capabilities and products. 

... Please send me information as checked below:

- |                                              |                                                                |
|----------------------------------------------|----------------------------------------------------------------|
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| <input type="checkbox"/> Cool Gas Generators | <input type="checkbox"/> Squibs, Pressure Cartridges, Igniters |
| <input type="checkbox"/> Hot Gas Generators  | <input type="checkbox"/> Other _____                           |
| <input type="checkbox"/> Pressure Terminals  |                                                                |
| <input type="checkbox"/> A Facilities Report |                                                                |

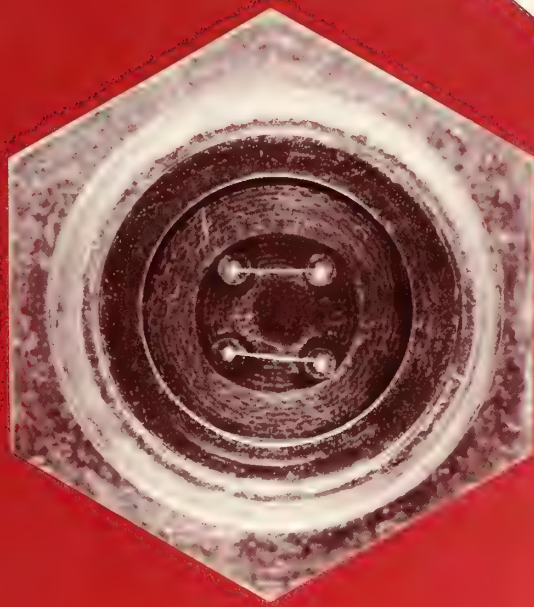
Name \_\_\_\_\_

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*small rocket motors / igniters*

*exploding bridgewire systems*

SPACE VEHICLES / INDUSTRY

WEAPONS SYSTEMS / AIR-

CRAFT / ROCKETS / MISSILES

*Atlas / Mercury / Polaris / Pershing*

*Bomarc / Jupiter C / Minuteman*

*Titan / Sidewinder / Saturn / Falcon*

*Discoverer / Sparrow-III / B-47*

*B-52 / B-58 / F-104 and Others*

**MCCORMICK SELPH**



(Continued from page 87)

line with changes in the overall national booster program.

**Centaur**—\$56.4 million.

**Liquid Propulsion**—\$93 million (including \$57.3 million for the *F-1*, \$28.7 million for the *J-2* and \$7 million for advanced systems and components).

• **Staff growth**—Marshall's present total payroll stands at about 5750 people—an increase of about 250 over the approved level for FY '61. The center's present plans call for adding about 750 additional people by next spring, bringing the total payroll to more than 6500.

This increase is more than 400 fewer than NASA originally estimated in its revised budget last spring. However, even at 6500 Marshall will be nearly twice the size of the second largest NASA center—Langley.

Expansion of Marshall over the next several years is expected to push the payroll to more than 8000, possibly 9000 at the most. Any increase beyond this would be opposed by the center's top officials.

"We don't want to go to 10,000 and 15,000 and 20,000 people," Dr. Eberhard F. M. Rees, deputy director, said recently. "I hate even to go to 9000 if it can be avoided. We don't want to become a big, big outfit. Our charm has always been that we are a small, well integrated organization that can do things very, very fast."

• **Nine divisions**—In the last several months, Marshall has added to its organization two new project offices—one for production operations at Michoud, the other for lunar program planning. The center's technical operations continue to be divided among nine divisions.

Eight of the technical divisions are based at Marshall. The ninth—the Launch Operations Directorate (LOD)—is based at Cape Canaveral.

—The LOD is responsible for all operations in connection with the launching of all NASA boosters and space vehicles on both the Atlantic and Pacific Missile Ranges. For this reason, there has been some consideration of a proposal to establish the LOD as a separate NASA center.

The eight technical divisions based at Marshall and some of their principal facilities include:

—The Aeroballistic Division, one of the smaller groups, conducts research in such areas as aerodynamic heating and external fluid properties. It also conducts flight evaluation of Marshall boosters. Its payroll totals 258 people.

The division's facilities include a 14-by-14-ft. trisonic wind tunnel, a 7-by-7-in. wind tunnel, a "hot shot" hypervelocity tunnel, and an atmospheric

missiles and rockets, November 27, 1961



*AERIAL VIEW of Marshall Center shows Saturn C-1 static test in progress. Facilities include 205-ft. superbooster dynamic test stand. Bigger stands are being built.*

sounding station that takes soundings daily up to 100,000 feet. It currently has under construction a hypersonic shock tube tunnel, a hypervelocity gun and a *Saturn* jet deflector facility.

—The Test Division conducts tests of boosters and rocket systems and components. It also conducts R&D in testing methods. The division payroll totals 618.

The division's facilities include the *Saturn* static test tower which can accommodate a rocket system with a total thrust up to 2 million pounds and is being modified into a double superbooster stand. A second test stand that can accommodate boosters with up to 4- to 6-million pounds of thrust is under construction. Its cost: \$10.8 million.

—The Fabrication and Assembly Engineering Division, widely known as the Fab Lab, is responsible for production of experimental superboosters and space vehicles and developing new technology and production methods. The division now operates in 22 buildings with a total floor space of 403,000 sq. ft. The division's payroll totals 841.

—The Quality Division is responsible for maintaining quality control on all vehicles. It also is responsible for maintaining a quality assurance program for launching systems and materials.

The division's main facility is an 111,000-sq.-ft. Checkout Building. Among other equipment, the division has an 18-ft.-diameter centrifuge capable of producing 30 g's. Total employees in the division: 399.

—The Research Projects Division is an idea factory under the direction of Dr. Ernst Stuhlinger. It is responsible for initiating and conducting original and supporting scientific research. The staff totals 65 people.

—The Propulsion and Vehicle Engineering Division conducts R&D in a wide variety of areas including structures, mechanics, propulsion, chemicals

and materials. It has two main buildings and nine smaller buildings housing laboratories and shops. A new five-story addition is under construction.

The division's nearly \$5 million worth of equipment includes a walk-in vacuum environmental chamber, a structural vibration tower, a 40-foot *Saturn* test tower and an aerodynamic heating simulation system. The division employs 730 people.

—The Computation Division operates one of the largest concentrations of computation equipment in the Free World. The Division has two main buildings. Its equipment includes two IBM 7090 computers, analog-to-digital conversion equipment, telemetry playback equipment, a frequency spectrometer, wave analyzer systems and a digital timing system. Total staff: 132.

—The Guidance and Control Division develops and performs pilot manufacture of guidance and control equipment. The main office and laboratory contains 192,000 sq. ft. Seven other buildings house various test and laboratory facilities. The division's special facilities include flight simulation equipment used for dynamic control studies. Total staff: 841.

• **In-house quality control**—The future of Marshall can be seen in its past.

As one top center official put it: "The government must be able to judge what industry is offering to it. There is a need for quality control. But to do this we always have had to have a good strong in-house project. Otherwise you quickly become out-of-date."

However, Marshall officials insist that this does not mean they seek to develop an arsenal system within NASA. As proof, they note pointedly that some 85% of *Saturn* hardware has been procured from private industry.

This is the pattern that is expected to continue to prevail. \*\*

# Apollo Awards to Flow from Houston

*Disbursement by new Manned Spacecraft Center may total \$10-15 billion through decade; 90-95% going in industry contracts*



ROBERT R. GILRUTH

*From Mercury to the moon—and beyond*

NASA'S NEWEST facility—the Manned Spacecraft Center now a-building at Houston, Tex., to handle *Apollo*—is destined to become one of its largest contract outlets.

Cost estimates for developing *Apollo* through 1970 vary from \$10 billion to \$15 billion—virtually all to be disbursed by MSC.

Renamed and expanded, MSC was formerly the Space Task Group which managed the *Mercury* program. Under its new charter, it will have not only the technical management and contract administration responsibility of *Apollo* and *Mercury*, but all of NASA's future manned spaceflight programs.

Of the billions to be spent by the center in the assault on the moon, NASA officials estimate some 90-95% will go in contracts to industry.

"We don't build anything ourselves around here," one official said, "even in our R&D programs we only build models and then contract with industry for the actual hardware."

The lion's share of the contracted funds will go to the three or four major contractors for the *Apollo* spacecraft development. Present plans call for one prime contractor to be responsible for the command and service modules and systems engineering for the whole spacecraft. Other contractors will be selected for the propulsion module, guidance and control, and the orbiting space platform which is still part of the *Apollo* program plan.

In the current fiscal year, MSC (STG) is spending \$294.5 million. Some \$54.2 million was allocated to Project *Mercury*, \$156.1 million for *Apollo*, \$24.1 million for salaries and expenses and \$60 million for construction of the new Manned Spacecraft Center.

• **More funds, faces**—A top official says the budget will more than double

in FY '63. MSC personnel complement will jump from its current 1000 to 1640. Eventually, the Houston facility will employ 3000 persons.

The new center will be headed by Robert R. Gilruth—the former director of STG. His top assistants will be Walter Williams and Wesley Hjornevik.

While the center's organization has not been finalized, current plans call for four main operating divisions.

These will break down into the following general areas: administration, research and development, preflight operations (including Astronaut training) and Project Office organization. The latter will have at least two divisions: one for *Mercury* and the other for *Apollo*.

Gilruth has not yet made a decision as to who will head the various operating positions, but the chiefs will undoubtedly come from top STG personnel. These could include: Paul C. Percer, Special Assistant to the Director, Maxime Faget, Flight Systems Division, Dr. Stanley White, Life Systems Division, Charles Mathews, Operating Division, G. Merritt Preston, Preflight Operations, and Bob O. Pilend—currently heading the *Apollo* contract evaluation.

• **Researching**—In addition to its contracting work in *Mercury* and *Apollo*, the Manned Spacecraft Center will be doing R&D work in the following fields including:

—Orbital Rendezvous—Many millions of dollars will be spent to determine the practicality of mating large vehicles in orbit for long journeys to the moon and planets. Much work will be done on this in Fiscal 1963.

—Follow-on manned space flight proposals including trips to Mars and 10- or 12-man expeditions to the moon. These will also involve R&D for spacecraft development.



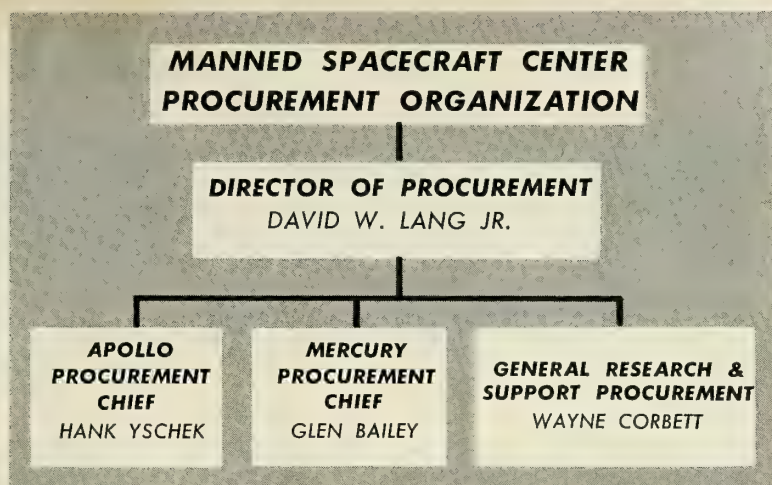
- Life support systems for spacecraft.
- New techniques for spaceflight, including guidance and control.
- Astronaut training and R&D for their equipment and environment.
- Work on re-entry and landing following the manned lunar landing.

According to the current time schedule, some 400 persons actively engaged in the *Apollo* program will begin moving to Houston in late December. By early March, all of STG's manned lunar operations will be transferred to the new center. Project *Mercury* personnel will not begin to move until late next summer. All of STG is expected to be transferred to the new site by the end of 1962.

• **The Plant**—Major facilities at the center include:

—Flight Project Building—To house the executive offices, project engineering offices, flight systems offices, and central management services, an eight-story, \$12,000,000 facility is planned. The building—providing approximately 340,000 sq. ft. of space—will serve as the management, engineering and service center for the Manned Space Flight Laboratory.

—Equipment Evaluation Lab—The Equipment Evaluation Laboratory and Support Facility provides the central services complex, including the shop and assembly areas for the preparation and repair of *Apollo* models and other equipment. The proposed buildings will be of standard milltype construction, with offices convenient to the shop and laboratory areas.



*MANNED SPACECRAFT CENTER'S internal procurement organization. In January, 1961, the office had a staff of 15. It has now grown to 65 and will hit 100 by the end of the year.*

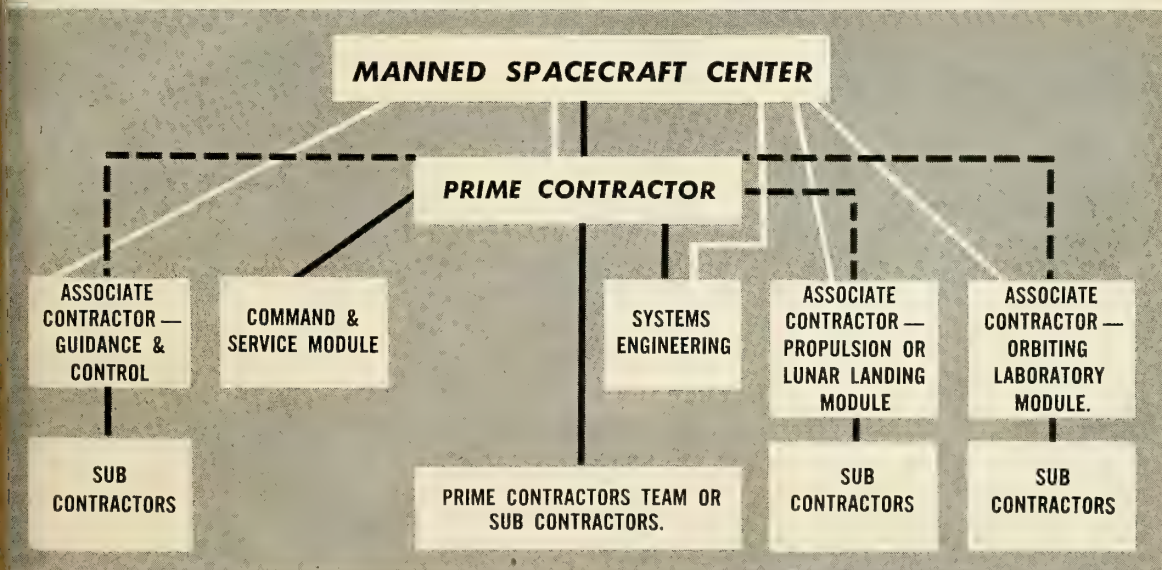
—Flight Operations Facility—Consisting of a three-floor, 50,000-sq.-ft. office section abutting the laboratory and training facility area of approximately 70,000 sq. ft., the \$3.6-million Flight Operations Facility provides an integrated center for the required mission simulation, as well as training equipment for the flight operations and training groups.

—Environmental Testing Laboratory—Facilities for testing the full-size *Apollo* spacecraft under critical in-flight environmental stresses will be provided in this testing complex. The main section of the building—a 100,000-sq.-ft. area—will provide for or-

derly spacecraft preparation, instrumentation, environmental testing and data handling. Adjoining the lab will be a two-story, 30,000-sq.-ft. office area and a submerged test cell of approximately 4000 sq. ft.

Other major facilities which will be needed in the future include:

- An extensive antenna range facility.
- Extensive electronics laboratory.
- Land area and facilities for testing all systems engaged in the manned lunar landing program.
- Centrifuge simulation.
- Equipment to simulate a manned lunar landing with 1.6 g's. **††**



**APOLLO INDUSTRIAL TEAM**—Prime contractor will be responsible for the command and service modules and the systems engineering for the whole spacecraft. Prime will also

set specifications for other modules (White lines show flow of that information). Dash lines show flow of progress reports. Flow of funds is separate to prime and associate contractors.

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EG&G Underwater Camera, Light and Sonar System



Fig. 1 17th Century Diving Bell.

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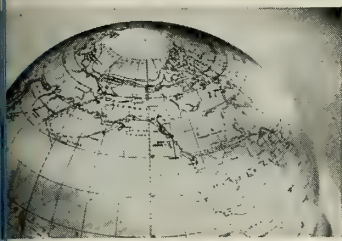


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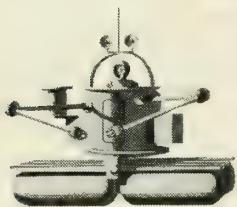
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WLD ARMY EMERGENCY WARNING SYSTEM

**Lunar VTOL Vehicle.** A rocket-propelled craft designed to collect lunar ore specimens.



**Nuclear Space Ship.** A Douglas design for a space ship with crew quarters and control rooms in the nose, nuclear reactor in the rear.

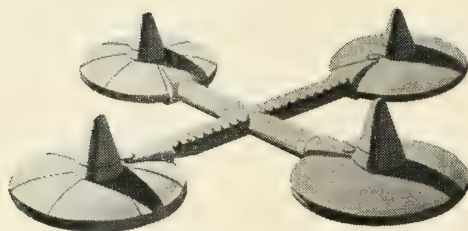


**Lunar Service Vehicle.** Travels like a "swamp buggy" on inflated rollers. Mechanical arms provided to handle outside chores.

**Nuclear Space Ship.** A future, medium-thrust, nuclear-electric space ship for one-year interplanetary round trips (Martian and Venusian).



**Douglas Thor.** Designed as a military IRBM, this dependable missile is the workhorse of the Space Age.



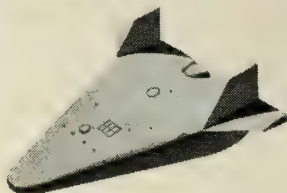
**Space Observatory.** Sections of this Douglas-designed space station would be sent into space in rockets and be joined together in orbit.



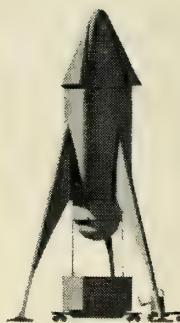
**Saturn.** First U.S. vehicle designed to put tons of payload into orbit . . . or onto the moon. Douglas-built second stage is as tall as a 4-story building.



**Nuclear Space Ship.** An unconventional design by Douglas with living quarters around the ring at the bottom. On landing, it would ease down, ring first.



**Supply and Escape Vehicle.** A compact re-entry vehicle to supply orbiting space stations or to return crews to earth.



**Lunar Cargo Handlers.** Would load lunar ore samples into containers to be towed back to earth by rockets.



**Lunarmobile.** Donut-shaped exploration vehicle to use rocket power in space and tractor treads on the moon's surface.

## Eleven ways to outwit the law of gravity

When the Space Age dawned, Douglas was ready with specific proposals for space equipment either completed or in advanced stages of development. (Some appear above.)

These Douglas proposals were based on *realistic* estimates of the capabilities of men and materials. They are the valued dividends of the company's considerable experience,

gained from the design and production of 30,000 missiles and rockets. These include the Douglas *Thor*, an IRBM which has been totally successful in 89.5% of its tactical and space firings over the past two years.

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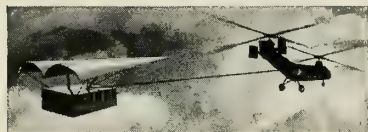
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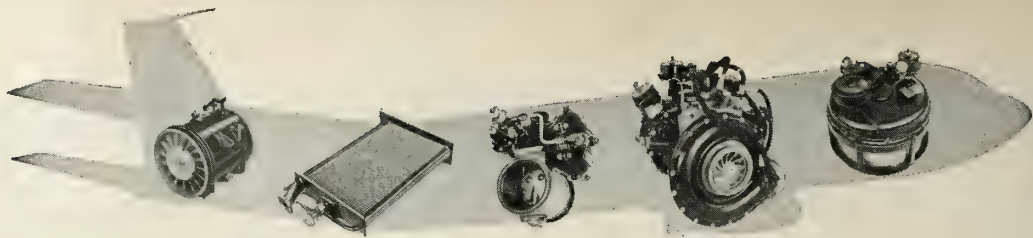
Ryan Flex Wing enables helicopters to tow several times the cargo or fuel they can carry

Ryan has received several contracts from NASA and the military services to explore and develop the more promising Flex Wing applications. Pioneering an entirely new concept, such as Flex Wing, is typical of Ryan's Space Age capabilities.

Ryan Aerospace—Ryan Aeronautical Company, San Diego, California.

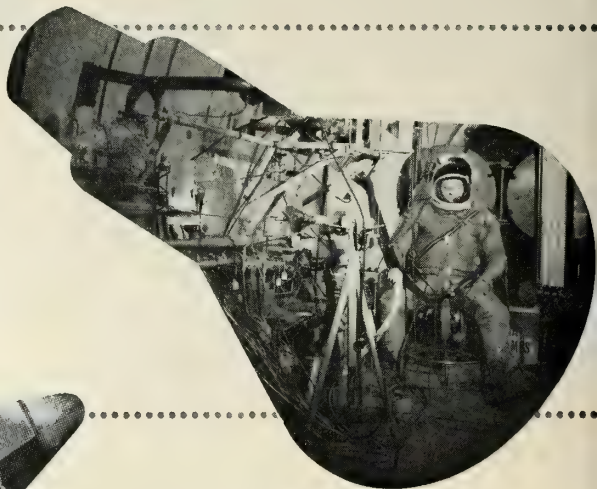
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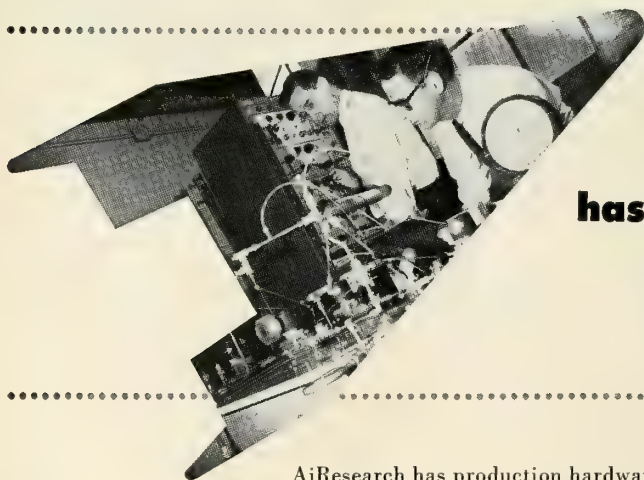


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# JPL Speeds Lunar Work for Apollo

*As its expenditures double, Lab is expected to maintain or increase industry's lion's share of dollars*

CALTECH'S Jet Propulsion Laboratory, with prime responsibility for NASA's instrumented exploration of the moon and planets, will nearly double these programs in FY '63 to meet the stepped-up demands of the manned space program.

This is the breakdown:

- **Lunar**—About \$55 million more, including additional *Ranger* vehicles to support *Apollo*, and soft-landing *Surveyor* vehicles.

- **Planetary**—Program to be more than doubled by an additional \$38 million.

Most of the step-up will occur in the lunar program, because of *Apollo* acceleration. Lunar program funding will be boosted to \$109.5 million from its current FY 1962 figure of \$64.3 million.

About \$40 million of the additional money will buy four more *Ranger* vehicles designed to support *Apollo* directly by shooting closeup television pictures of the lunar surface before impacting on the moon.

More soft-landing *Surveyor* vehicles also are expected to be added, but how many remains to be determined, according to Clifford I. Cummings, JPL lunar program director.

JPL's planetary program, although not affected by *Apollo*, will come in for the biggest proportionate increase in Fiscal 1963, going to some \$68 million, or more than double the current budgeted \$30.5 million, Carl Jorgensen, manager of financial planning, told M/R.

- **Maintaining "mix"**—JPL's need to develop and maintain its ability to manage contractors affects its contracting procedures and how much money goes off-lab. R. J. Parks, planetary program director, said JPL must maintain "an appropriate mix" of in-house and contracted work.

"A sufficient fraction of the planetary systems programs will be kept in-house in order to keep up our capa-



DR. WILLIAM H. PICKERING

*No intention to compete in production.*

bility," he said. "At present, this means JPL will keep the entire systems responsibility for *Mariner*. In the future, more and more of these projects will be contracted to industry. This may come in the *Voyager* series."

Dr. F. E. Goddard, head of advanced planning, said details as to how JPL will spend much of its additional funds are yet to be determined because the unmanned program is under re-examination "to see that it will support *Apollo* to the fullest possible extent."

"Certainly, industry will have to provide a lot more of the known central needs of the program," he said. "This means more vehicles, tracking capability, and technical development in all fields. In order to accelerate the program, we will have to fire more vehicles in development and operational test runs."

- **Trend toward contracts**—A highly reliable industry cue is provided by JPL's outside spending in the past two years: In Fiscal 1961, the lab

spent \$50 million of its \$79-million budget outside, and in the current year expects to commit \$116 million of its \$156-million budget to business and industry.

JPL has 262 contracts, with a current total face value of \$52 million. These range from study programs to contracts for development of flight hardware and ground support equipment, with the main portion involving electronic design and fabrication. They also include contracts for JPL's continually-growing facilities.

In addition, the lab spends about \$500,000 a week through its purchasing section for everything from paper clips to basic off-the-shelf spacecraft items such as harness assemblies. The lab's latest six-month report shows that about 70% of the purchasing section awards, totaling 40% of money spent, go to small business.

As a non-profit organization operated by CalTech under NASA contract, JPL's policy is to spend the major portion of its funds outside the laboratory. "We have no intention of becoming engaged in production-type activities in competition with industry," says JPL Director Dr. William H. Pickering.

Pickering's deputy for business administration, Val Larsen, whose support organization employs more than a third of JPL's staff, said the laboratory's problem "is to get this big job done and we don't have the facilities or manpower to do it in-house." JPL has a staff of 2847, of which 863 are scientists and engineers.

"What must be done here is fundamental research, origination of concepts and some advanced development work on hardware that might be used to accomplish a mission five years from now," Larsen said. "There are certain components or subassemblies which are beyond the present state of the art and which must be proven feasible before they can be handed over to industry for further development."

- **Other factors**—In addition to in-



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creased space effort, there are two other factors which should mean a rise in the amount of business JPL lets out:

—The continual demand for new capabilities.

—NASA to turn over to industry some of the work JPL now does in-house as a matter of its own staff training.

When full responsibility is kept in-house, JPL goes to its technical divisions for the subsystems. The divisions, in turn, almost always go to industry. In the second case, JPL selects a contractor to design, build and fire the vehicle.

Parks pointed out that even when JPL retains full responsibility, a high percentage of the money goes off-lab—about 75% in the case of *Mariner*, which currently accounts for about 95% of the entire planetary program budget.

In the lunar program, JPL has retained *Ranger* in-house, while contracting for complete spacecraft systems responsibility for *Surveyor*. JPL developed the prototype vehicle for *Ranger* and then asked about 1500 subcontractors and suppliers to provide the hardware.

*Prospector*, on which decisions still are to come on how it can best support *Apollo*, will be an out-of-the-house program.

• **Contractor contracts**—In outlining procurement policies, Larsen emphasized that the lab is a contractor to the government in the same way an industrial firm may be a prime contractor. Thus, in working under JPL contract, a firm is, in effect, dealing with "another commercial organization" under subcontract.

If the laboratory knows exactly what it wants as to specifications, the industry assistance and evaluation group provides a list of qualified firms who are asked to submit proposals. The result usually is a fixed-price contract.

Cummings gave M/R this rundown on procurement procedure involving a major project such as *Surveyor*:

"A lot of people in industry are doing informal studies based on very broad guidelines. They develop conceptual advanced studies and then ask for a preliminary run-through on our thinking in hope of getting us to react. We agree to these presentations on the basis that these people definitely have something to contribute. We gain some ideas, and, we hope, they get a better picture of our thinking.

"Meanwhile, as the status of launch vehicles and overall scheduling and funding begins to ripen in NASA planning, we go to NASA headquarters with a preliminary project development plan. This gives NASA a broad outline of what we expect to set forth

on mission objectives, scheduling, and gross funding. We also indicate project management and procurement procedure.

"After NASA approves it, we are free to invite 30 or 40 contractors to a bidders' conference. In the lunar program, we want those who have been here before and have something worthwhile to contribute, those with obvious systems talent. In the planetary program, you get a different twist—they may be looking for subsystems contractors.

• **Spreading the word**—"At the conference, we try to give good information so those attending can pass it on to the subsystems people. In the *Surveyor* program, conference tape recordings were sent to all who attended.

"Our object at this stage is to choose some contractors who will perform the competitive (partially or fully funded) studies. For this we want organizations that can go beyond the study stage and perform the full responsibility.

"But we do not want a technical proposal at this time. We want a proposal on how a contractor would carry out the study, how he would manage the project, and how he would organize to handle the actual hardware program. The selection process is very sensitive to what he plans to do. We also want the names of the (company) people who actually will be doing the work.

"After these proposals are in, we select the few competitive study contractors who really can do what they say they can do. We select, say three, to do a formal (paid) study. We provide them with the requirements and constraints as the basis for their competitive design studies.

"When they have finished, they turn in the studies along with their proposals for implementing the program and their proposal on program approach—how many test vehicles, how much money, phasing, manpower.

"Next, a source evaluation board is formed of senior JPL people and NASA representatives. The board's findings are given to the NASA Administrator. He makes the selection, and then we can enter contract negotiations."

Cummings said JPL is "not interested" in unsolicited proposals by the time the bidders' conference is called. However, JPL welcomes all informal proposals.

Since Dec. 3, 1958, when the government-owned laboratory was transferred to NASA, JPL has built up a capability to conduct any phase of systems work and research on unmanned space missions.

Following transfer to NASA, JPL underwent a complete reorganization which resulted in creation of eight tech-

missiles and rockets, November 27, 1961



nical divisions: systems, space sciences, telecommunications, guidance and control, engineering mechanics, physical sciences, engineering facilities and propulsion.

Support activities were grouped into six service and support divisions: personnel and technical services, procurement and contracts, financial management, plant engineering services, material services, and fabrication services.

• **Shopping**—In keeping with the policy of "making the fullest possible use of industry," the technical divisions often go off-lab for 60% or more of their needs.

Dr. Albert R. Hibbs, chief of the space sciences division, mainly concerned with scientific instrumentation with which to explore space, said his organization prefers to have industry develop its flight hardware.

"But we customarily do not turn to industry for scientific research," he added. "We find that generally the stronger scientific inputs and research concepts come from universities, where the people have time to devote thought to it."

Fabrication services division is another example of how JPL must go outside to fill its needs. The division, while operating a fully-equipped machine shop, can provide only 20% of what must be fabricated for research and development purposes.

• **Plant growth**—JPL's 140-acre Pasadena installation, which currently consists of 180 buildings totaling 598,000 sq. ft., three wind tunnels, and 180 leased trailers, is authorized in its FY '61 and '62 construction program to spend \$10.6 million for another 291,000 sq. ft. of office, laboratory, and shop space. In FY '63, JPL plans to add another 180,000 sq. ft. of similar facilities at a cost of \$7.3 million. Present facilities are worth \$35 million.

Existing facilities, in addition to the Pasadena installation, include the Deep Space Instrumentation Facility spread over 50 sq. mi. at Goldstone Dry Lake, Calif., and consisting of two 85-ft. antennas and 16 support buildings; a 590-acre propulsion research and development facility at Edwards AFB, Calif.; and engineering and testing installations at Cape Canaveral, Fla. The DSIF also has stations at Woomera, Australia, and Krugersdorp, South Africa, with giant receiving antennas.

The Edwards AFB installation, which has four test stands and employs 50 persons, is in the process of adding \$1.3 million in new structures for solid-propellant research, including a new test area and a solid-propellant processing facility. ❧



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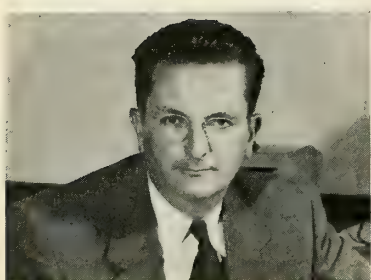
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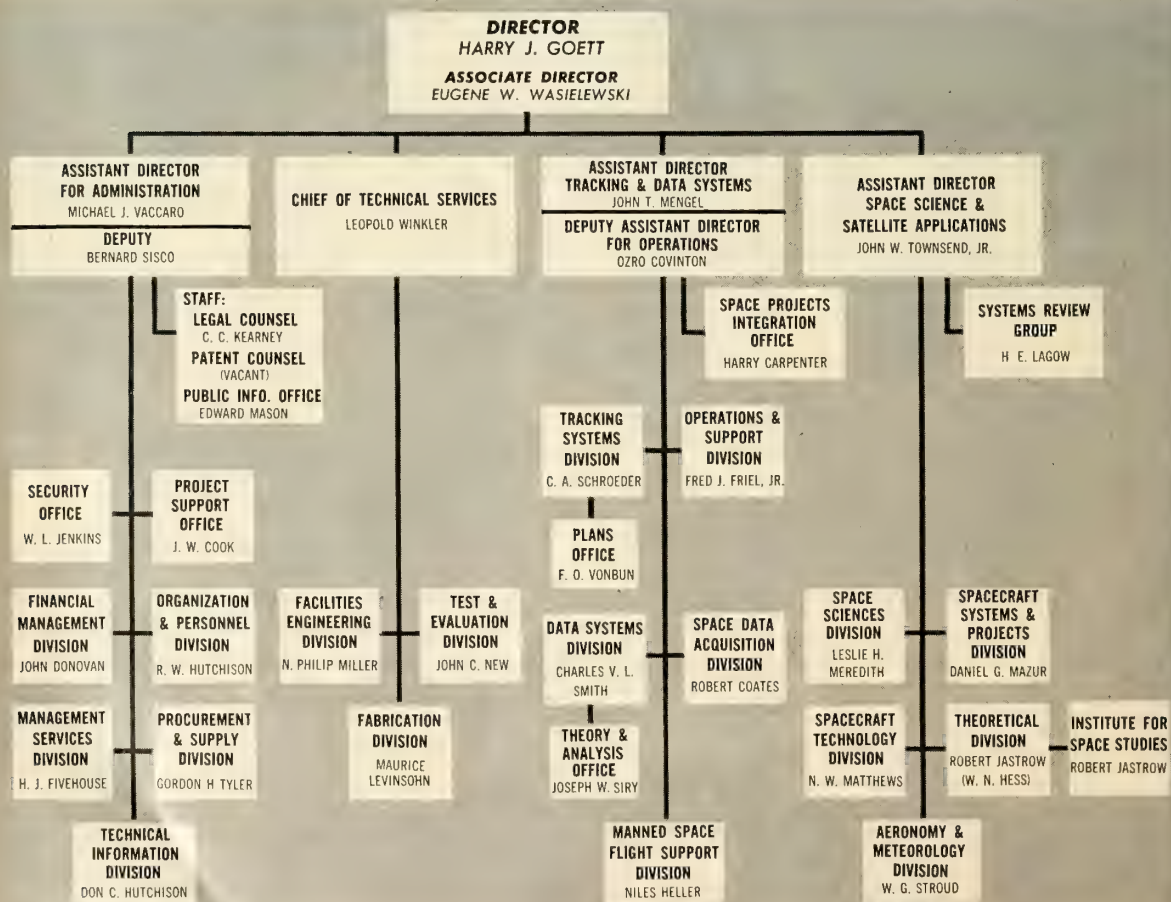
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# Goddard's Swelling Funds Tagged



**HARRY J. GOETT**—Youngest center stresses science data.

*Newest installation will also have big part in Apollo tracking; four-fifths of contracted R&D should be invested with industry; stable of satellites enlarges*





# Mainly for Unmanned Craft

GODDARD Space Flight Center, newest of NASA's nationwide complex of installations, is expected to receive a 25% increase in its FY '63 budget to push the unmanned satellite program.

The 25% boost would increase spending at Goddard to about \$250 million a year.

Moreover, Goddard will receive an additional boost in funds from the Weather Bureau specifically for the development of weather satellites.

The bulk of Goddard's budget will continue to be spent on the unmanned satellite program. However, the center is also expected to play a major role in tracking in the *Apollo* program.

Judging from precedent, industry can expect to get upward of 80% of the Goddard budget for contracted R&D, which includes money for supplies and materials for the Center's in-house research.

• **\$162 million for R&D**—Since Goddard's end product is scientific data, the Center's organization chart reflects a corresponding emphasis. Thus, of the four assistant directors reporting to the Center's director, one is in charge of "Space Science and Satellite Applications," and the other, "Tracking and Data Systems." The two remaining assistant directors take care of technical services and administration.

The Space Science and Satellite Applications group—the largest, with between 600 and 700 people, has two application satellite programs: meteorological and communications. R&D for these command the most money—\$62 million out of Goddard's \$162-million budget for FY '62 R&D. (Goddard's total budget for FY '62 is \$206 million.)

Runner-up is the scientific satellite program, budgeted at \$44 million for R&D.

• **Application satellites**—The meteorological satellite program consists of *Tiros*, *Nimbus* and the follow-on operational weather satellite, *Aeros*.

Three *Tiros* satellites have already been successfully launched and five more launchings are planned for the

next year and a half. Intended to scout the earth's cloud cover, the advanced *Tiros* satellites will see successive growths in their infrared instrumentation, with continuous orientation to the earth for photo purposes.

First launching of the second-generation weather satellite *Nimbus* is expected toward the end of next year. From that time on, one *Nimbus* is to be operating in orbit almost continuously.

R&D for the 24-hour meteorological satellite *Aeros* is not expected to start for a few years. Studies indicate, however, that the operational system will use three or four satellites displaced around an orbit.

Only now being figured into NASA's planning is one factor that may spur the meteorological program on: early in October, President Kennedy signed a bill giving the Weather Bureau \$48 million to carry out a weather surveillance program. Of this money, Goddard will receive and spend about \$45 million on systems management.

"Our job is to provide and operate the weather satellites and ground stations," a top NASA official told MISILES and ROCKETS. "We're starting now."

This \$45 million—part of the supplemental FY '62 budget—will enlarge Goddard's staff beyond the projected 2300-man payroll expected by the end of this calendar year.

• **Communications satellites**—The communications satellite program, comprising passive and active types, is getting a big push because of commercial as well as government interest.

Next year, the 135-ft.-balloon *Echo II*, a passive communicator, is to be launched. Subsequently, under the *Rebound* project, an attempt will be made to launch three or more *Echo*-types from a single *Atlas-Agena* vehicle and to disperse them in orbit.

Among the active communications satellites Goddard is involved in are: *Relay*, an active transponder being developed by RCA for launch in late 1962 or early 1963; *Syncom*, a 24-hr. repeater with spin and altitude stabiliza-

tion, being developed by Hughes for late 1962 or early 1963 launch; and *Telesat*, an AT&T experimental industry communications satellite, the first of four scheduled for 1962 launching.

Goddard scientists say that the biggest problem is to develop a communications satellite that will continue to operate for long periods. Solving this problem involves getting an altitude control with adequate reliability, and a power supply that is rugged, light, and long-lived—this last, the universal quest of equipment developers.

• **Scientific satellites**—The scientific satellite program includes orbiting solar observatories (*OSO*), orbiting astronomical observatories (*OAO*), orbiting geophysical observatories (*OGO*), an atmospheric structure satellite (*S-6*), a series of satellites for international programs, principally geodetics, and several others.

Preparations are now being made for launching an *OSO*—a stabilized satellite whose instruments point at the sun. About six *OSO*'s are expected to be sent up in the next two or three years; after this, improved *OSO*'s will be sent up in a continuing program.

The plan is to start launching *OAO*'s in late 1963 or early 1964, and continuously after that. The hope is to have one operating in a satisfactory orbit at all times, which may involve one or two launches a year.

*OGO* will be the workhorse for the geophysicist, taking from 30 to 50 different experiments on each satellite. The 1000-lb. satellites—scheduled for first launch in 1963—will be sent on polar orbit (*POGO*) or on a highly elliptical orbit (*EGO*) similar to the *Explorer XII*.

The *S-6* will be sent up next year to measure density, pressure, temperature and composition of the upper atmosphere.

The first of the international scientific satellites (*S-51*) will be launched for the United Kingdom in 1962. A second U.K. satellite (*S-52*) is in early phase development. Goddard is also providing management for launching a



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Canadian topside sounder (S-27) which is to go into a polar orbit in 1962.

• **Tracking and data handling—**

Another \$44 million of the Center's FY '62 R & D budget will go to industry for tracking and data work, which includes updating equipment, and operating and maintaining *Mercury* and *Minitrack* networks.

For manned spacecraft such as the coming *Apollo*, Goddard directs a global ring of stations which provide tracking, telemetry and communications activities. Dual IBM 7090 computers, with "real-time" channels, make constant flight contingency recommendations and predict flight paths, impact points of the capsules and velocity vectors on a near zero-lag continuing basis during the mission.

The tracking problem for unmanned as well as prospective manned vehicles is expected to grow increasingly difficult, particularly with scientists wanting increasingly radical orbits. Moreover, the data-handling and reducing problem becomes monumental.

"We're good customers of the computer companies," a NASA engineer said. "We're always on the lookout for ways to handle our data faster and cheaper. Man, what we wouldn't give for this!"

For each hour *Explorer XII* is in orbit, it costs the Center an hour of data reduction. In 32 days, the satellite's telemetry filled 3200 magnetic tapes. "We could never reduce all the data," the engineer added. He pointed out that the center has five IBM 7090 computers and also rents time outside, "and it's still an unrealistic job."

Even so, the Center is striving to cope with the problem. The data handling group was expanded recently and is trying to do as much data reduction as possible for the experimenters—short of final scientific reductions.

• **Sounding rockets**—The sounding-rocket program—the upper-atmospheric program that came from the Naval Research Laboratory—accounts for \$7 million of the R&D budget. The vertical probes are used for exploring in and beyond the earth's atmosphere. They are also used to test out instruments destined for satellite work.

The 1961 schedule called for 83 Goddard-managed sounding rockets to be launched. Over 175 launchings are planned for 1962, and these include

**Funding for Goddard Space Flight Center**

(millions of dollars)

|                         | FY '61     | FY '62     | FY '63<br>(est.) |
|-------------------------|------------|------------|------------------|
| Contracted R&D          | 213*       | 162        | 200              |
| Salaries & Expenses     | 25         | 28         | 37               |
| Construction & Expenses | 14         | 16         | 15               |
| <b>Total</b>            | <b>252</b> | <b>206</b> | <b>252</b>       |

\* Includes \$87 million to support the Space Task Group, then part of Goddard.

some shots made in cooperation with England, Australia and Japan.

Other R&D programs amounting to \$2 million bring the total Center expenditure for contracted R&D for FY '62 to \$162 million.

The total R&D program budgeting is based on "incremental" programming that is, programs are budgeted on a yearly basis. (Goddard's budget does not include the cost of launch vehicles which are paid for out of NASA headquarters money.)

• **Goddard's non-R&D money**—Approximately \$28 million out of the Center's current budget is going for salaries and expenses, which include equipment and computer rentals in addition to building rentals. Moreover, \$16 million is earmarked to continue the Goddard construction program; this figure also includes \$6 million for *Minitrack* network buildings and facilities.

The Center is located on 550 acres in a rural area near Greenbelt, Md., about 10 miles northeast of Washington. With four major buildings completed and occupied and four more under construction, the space agency complex will comprise 11 buildings before the end of 1963 at a total cost of more than \$37 million.

Most of Goddard's personnel are at the Greenbelt site or occupying temporary space which will be vacated as soon as the appropriate Center buildings are finished. However, some members are operating world-wide tracking network stations under Goddard's far-flung operational communications wing.

In May, the Goddard Institute for Space Studies was established in New York City. Its mission is to build up the space program in its broadest scientific aspects. Headed by Dr. Robert Jastrow, the facility was put in New York so there could be an easy interchange of ideas between NASA and the universities. There are 25 people in the group now—fellows, professors and graduate students besides NASA personnel—and it is expected to go to about 40.

missiles and rockets, November 27, 1961

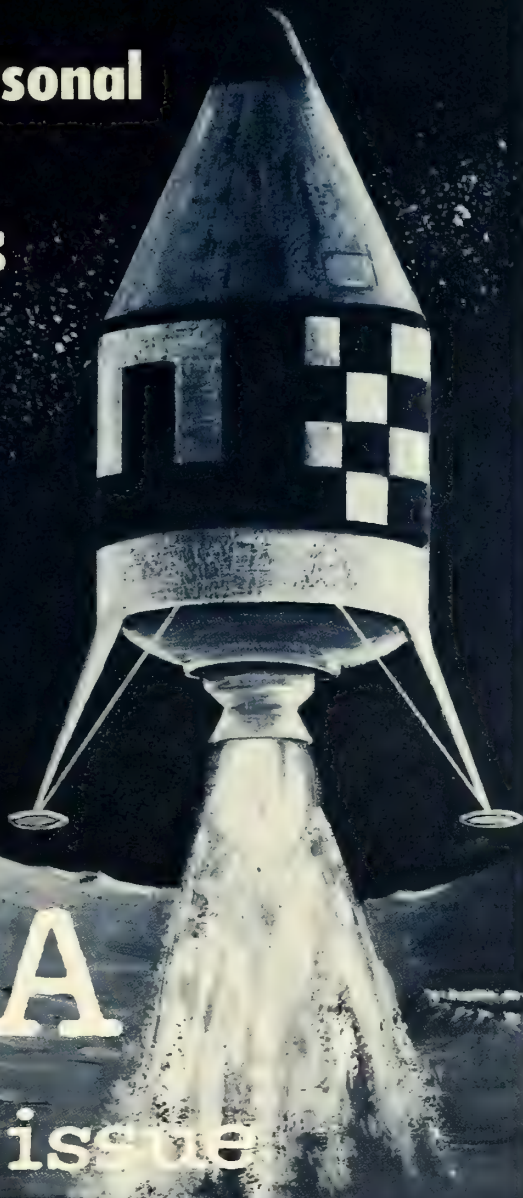


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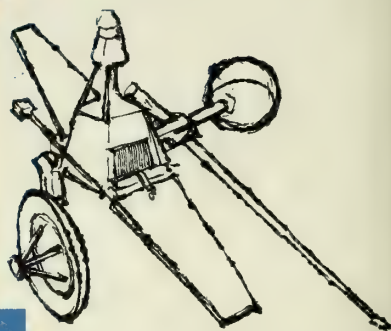
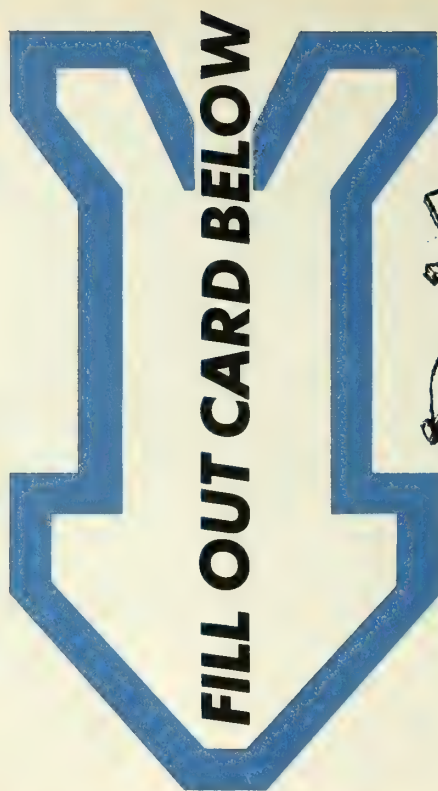
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• **Selling to Goddard** — All the money that Goddard spends with industry goes through the Procurement and Supply Division, headed by G. H. Tyler. Usually, major procurement—essentially R&D—commands 90% of the money, leaving about 10% for standard purchases such as off-the-shelf items.

Goddard buys all the equipment and facilities needed to support its mission.

Potential R&D contractors and prospective suppliers are strongly advised to make their initial contact with H. J. O'Toole, Chief Facilities Source Office, Goddard Space Flight Center, Greenbelt, Maryland. (The present physical location of this office is in Washington, D. C.)

Since O'Toole is fully informed about the needs of Goddard, he brings technical personnel into meetings with appropriate Center R&D contractors. Where needed, he performs a similar service for suppliers.

In addition, O'Toole circulates to interested Center personnel the company literature and brochures furnished to him. Moreover, he maintains the procurement source file which is the basic reference file used by the Procurement and Supply Division.

Companies wanting to do business with Goddard are urged first to write a letter to O'Toole, including with it: (1) Standard Form 129 (application form for being entered on bidders' list); (2) DD Form 558-1, which is supplement to Form 129; (3) biographies of scientific and engineering staff (for R&D contracts); and (4) supporting brochures and other pertinent literature. (The forms can be had from any government purchasing office, civilian or military.)

The division is adamant about not wanting "strollers" or subcontractors to visit.

The Division also suggests that suppliers of parts and equipment correspond rather than visit—unless a unique product or breakthrough is involved. If a visit is planned, then the Division recommends that a letter be sent to set up an appointment.

R&D proposals under one million dollars may be evaluated by a Board of technical and business personnel. The procurement decision is made by the contracting officer.

When the proposal involves expenditures of over one million dollars, the Board evaluates it according to pre-established criteria, and the decision is made by the Center's Director.

When over \$5 million is involved, the Board again evaluates but the final decision is made by the NASA Administrator. (These procedures do not apply to building construction contracts.) ■

missiles and rockets, November 27, 1961

The advertisement features a dark background with several missiles and rockets depicted in white and red. The missiles are labeled with their names: ATLAS, POLARIS, MACE, THOR, REGULUS, MATADOR, and BOMARC. The text is arranged in a central column, with the company name at the top, followed by 'has made', then the model number '6147', the product name 'GYRO TEMPERATURE CONTROLS', and finally 'for these missiles'.

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# WOO Awaiting West Coast Upsurge

*Staff of Western Operations Office being doubled  
in anticipation of lunar program; business now tops \$603 million*

THE WESTERN Operations Office—nicknamed WOO—is NASA's contract manager and technical watchdog on the West Coast.

As WOO Deputy Director Donald R. Mulholland explains it: "We receive a steady stream of queries from NASA centers asking what is going on in industry. We go and ferret out the information."

However, the primary mission of WOO, which has no R&D facilities, is contract negotiation and the management of R&D contracts with West Coast companies.

In FY '62 alone, WOO Director Robert W. Kamm expects his group to disburse nearly \$300 million in contracts. In the same period, WOO's internal budget is only \$1.4 million. WOO's staff is currently being nearly doubled to 119.

• **The Big Seven**—The office currently lists on its books 201 contracts, worth \$603,030,000. Of this number, WOO actually has contract management responsibility for only 62, acting in a supporting role on the others. The 62, however, add up to \$535,409,000—of which all but \$3.6 million is contained in seven major contracts.

The seven include: California Institute of Technology's Jet Propulsion Laboratory, \$227,190,000; *Saturn S-IV* (Douglas Aircraft Co.), \$81,890,000; *Saturn S-II* (North American Aviation), \$975,000 (currently negotiating for a nominal size of \$150 million); F-1 engine (North American Aviation), \$109,358,000; H-1 engine (North American Aviation), \$37,525,000; J-2 (North American Aviation) \$46,450,000; *Delta* vehicle (Douglas) \$28,353,000.

Earle J. Sample, WOO's contracting



ROBERT W. KAMM

*Organized across-the-board for big push*

officer, gave this rundown on contracts:

"The 62 contracts have been assigned to this office for contract management. The remainder are contracts on which I am not contracting officer, but on which this office has been delegated a supporting role of some sort.

"This includes project monitoring, perhaps making payments, and giving expediting assistance. In some cases, a NASA center feels that the contracting officer ought to be at the center. A contract may be somewhat sensitive. Sometimes a contract may not be big enough to warrant the administration delay of transferring it out to us. It may be a one-shot study job."

• **Subcontract control**—In explaining his role, Sample said that in the event a contractor, such as the Jet Pro-

pulsion Laboratory, wants to place a subcontract, it must obtain his permission and provide assurance that the proposed subcontractor can perform technically and financially and that his price is fair. In the case of small subcontracts which do not require prior consent, Sample maintains surveillance by reviewing purchasing procedures.

In project monitoring, members of the technical staff act as on-the-spot representatives of NASA project offices that are involved.

Still another part of the technical mission is quality engineering.

"Our technical people, through surveys and inspections, evaluate the effectiveness of the contractors' quality and reliability programs, and make recommendations where improvement is needed to meet NASA's high reliability requirements," WOO director Kamm said.

• **Balanced team**—To meet its tasks, WOO has an "across the board organization" which includes contract administrators, engineers, scientists and attorneys. In addition to the technical division, there are divisions for contracts management, financial management, administrative services, security and public information, WOO also has a legal office employing three patent attorneys.

An added responsibility is providing administrative support for personnel which other NASA centers assign to projects in the Western area. About 50 NASA representatives currently are on each assignment, including those in a headquarters audit group, an *Agency* project group at Sunnyvale, Calif., and a *Centaur* project group at General Dynamics/Astronautics in San Diego, Calif.



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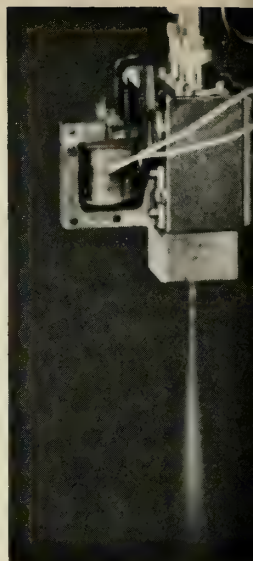
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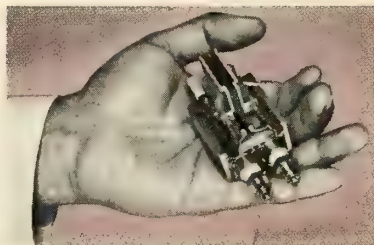
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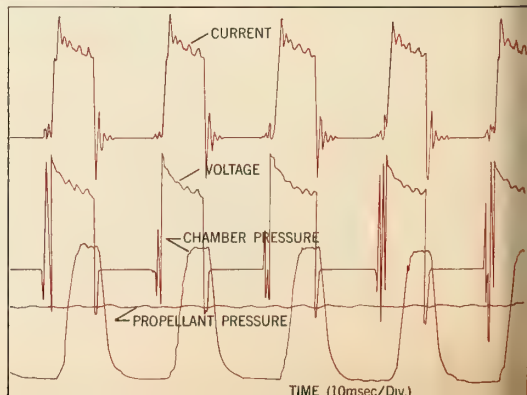
vides a solid base for work in the relatively new field of space vehicle reaction controls. The intensive development program has evolved a basic design principle that can be readily applied to provide control rocket thrust levels to meet any foreseeable requirements.

Get more details by writing for Bulletin A-6005. Vickers Incorporated, Division of Sperry Rand Corporation, Detroit 32, Michigan.



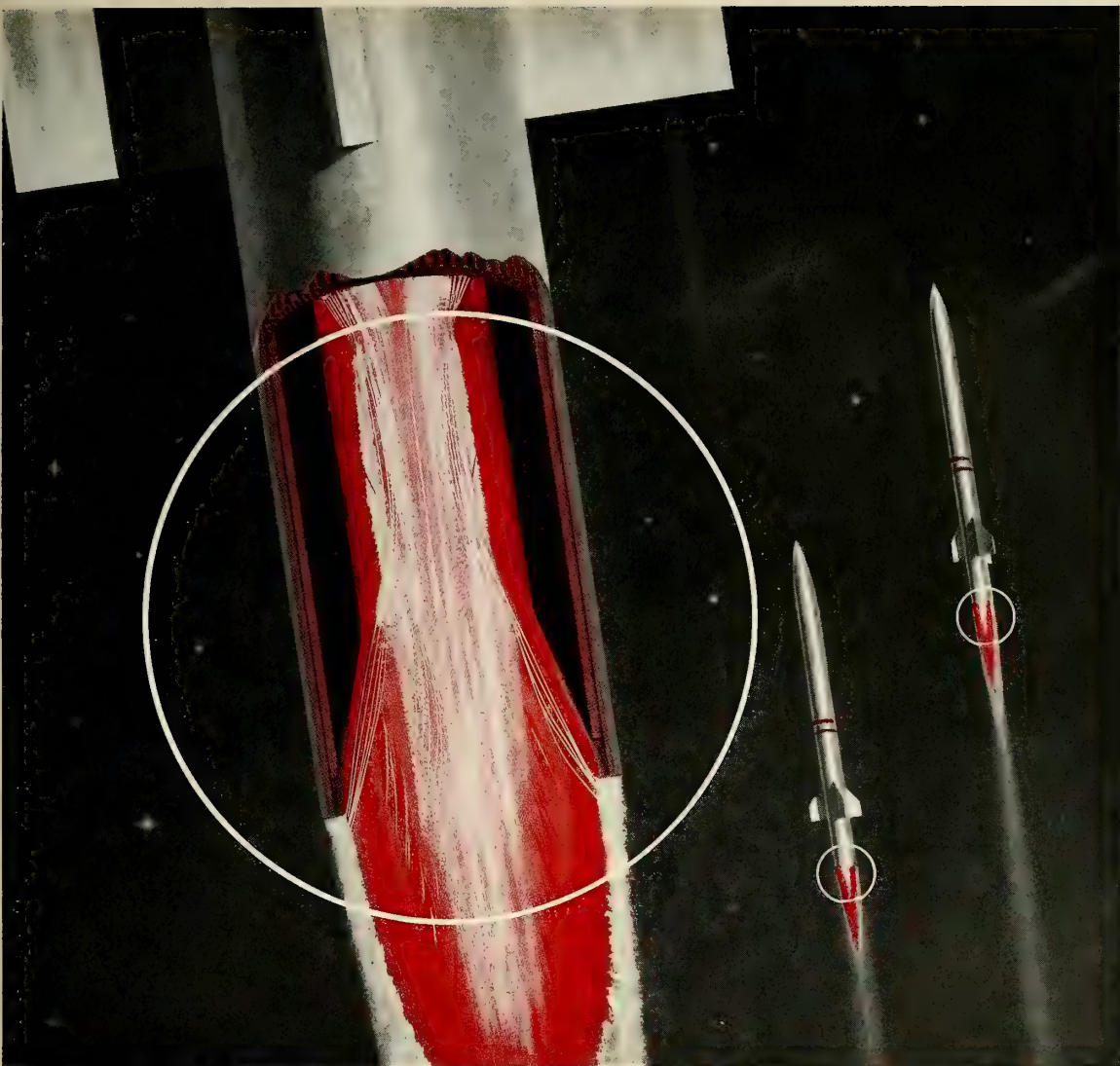
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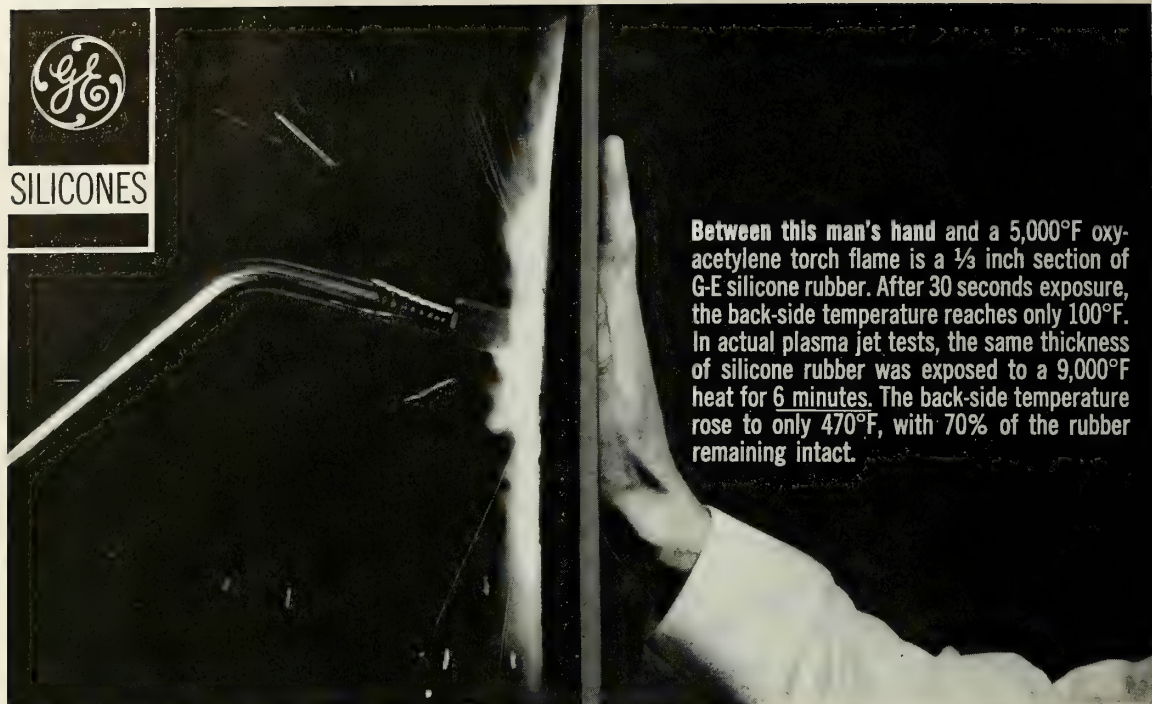
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SILICONES



Between this man's hand and a 5,000°F oxy-acetylene torch flame is a 1/4 inch section of G-E silicone rubber. After 30 seconds exposure, the back-side temperature reaches only 100°F. In actual plasma jet tests, the same thickness of silicone rubber was exposed to a 9,000°F heat for 6 minutes. The back-side temperature rose to only 470°F, with 70% of the rubber remaining intact.

## Thermal barrier against 5000°F flame

### GENERAL ELECTRIC SILICONE RUBBER



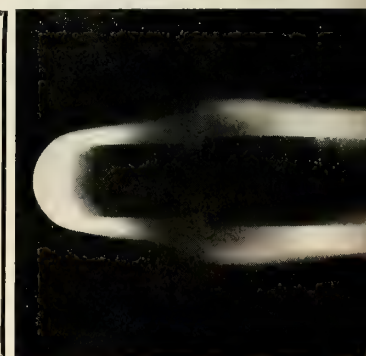
The surface of the tested rubber section forms a hard, carbonaceous crust, while the underside remains flexible and undamaged. Preliminary tests showed the effective heat of ablation to be eight times better than presently used plastics, with one-seventh the rate of ablation and one-fourth the weight loss. Here is an excellent ablative covering with low thermal conductivity.

#### RESULTS OF PLASMA JET TESTS AT 9,000°F

Flight Simulation  
Vel. = 17,000 ft./sec.  
Alt. = 250,000 ft.

| Exposure time at 9,000°F | Back-side temperature of 1/4 inch section of G-E silicone rubber |
|--------------------------|------------------------------------------------------------------|
| 30 seconds               | 100°F                                                            |
| 2 minutes                | 210°F                                                            |
| 3 minutes                | 300°F                                                            |
| 4 minutes                | 375°F                                                            |
| 5 minutes                | 430°F                                                            |
| 6 minutes                | 470°F                                                            |

The above chart shows how the high thermal insulation of G-E silicone rubber is maintained during exposure to 9,000°F heat. It is also useful in mechanical and electrical applications at temperatures from -150°F to 600°F, where it remains resilient and flexible. It also maintains its excellent physical and electrical properties over this wide temperature range for extended periods.



Continued high temperature testing goes on at General Electric's Missile and Space Vehicle Department in Philadelphia. Shown above is a typical specimen undergoing plasma jet testing in an electric arc heated supersonic wind tunnel. Continuous testing like this will develop new data on the thermal and ablative uses of G-E silicone rubber.

To learn more about G-E silicone rubber, and its uses as a thermal and ablative material, write: General Electric Company, Silicone Products Dept., Section 01161 Waterford, New York.

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# Cape's Billion-dollar Launch Complex

*Launch Operations Directorate due for 500% increase in funding next year, plans matching hikes in personnel and land area; Saturn pad-building starts next year*



**DR. KURT DEBUS**

*His staff and budget begin to quintuple.*

THE VAST Cape Canaveral spaceport, from which multimillion-pound-thrust boosters will soar to the moon and beyond, will cost the United States well over \$1 billion by 1970.

For FY 1963 alone, NASA's Launch Operations Directorate at the Atlantic Missile Range is seeking a total budget of \$500 million. Some \$246 million would be earmarked for the U.S. manned lunar landing program, \$17.8 million would go to R&D activities, \$9 million for salaries and expenses, and \$8.5 million for plant support.

In FY '64 and FY '65, it is estimated, the Cape's budget will hit \$200 million annually.

The sharp upsurge in spending compares to a FY '62 budget of a little over \$100 million—\$80 million for construction, \$19 million for R&D, and \$6.5 million for salaries and expenses.

With the increased budget will come a corresponding increase in employment. LOD's total force will jump from the current 510 people to 800 by mid-1962. In the 1965-66 period, it is expected to soar to 5000.

Both the funds and added personnel stem from the expanded U.S. space program, which is forcing a five-fold increase in the land area of NASA's Cape Canaveral installation. It will jump from its present area of 20,000 acres to 100,000 acres—25 miles long and 10 miles wide at its broadest point.

Into the expanded area will go launch pads and facilities for giant

*Saturn* and *Nova* boosters, an industrial area, and support and management buildings.

Land acquisition will be handled by the Jacksonville, Fla., district of the Army Corps of Engineers. The first purchase, totaling \$18 million, will be made shortly. Further funds to accomplish the total land purchase—estimated to cost \$60 million—will be requested from Congress early next year.

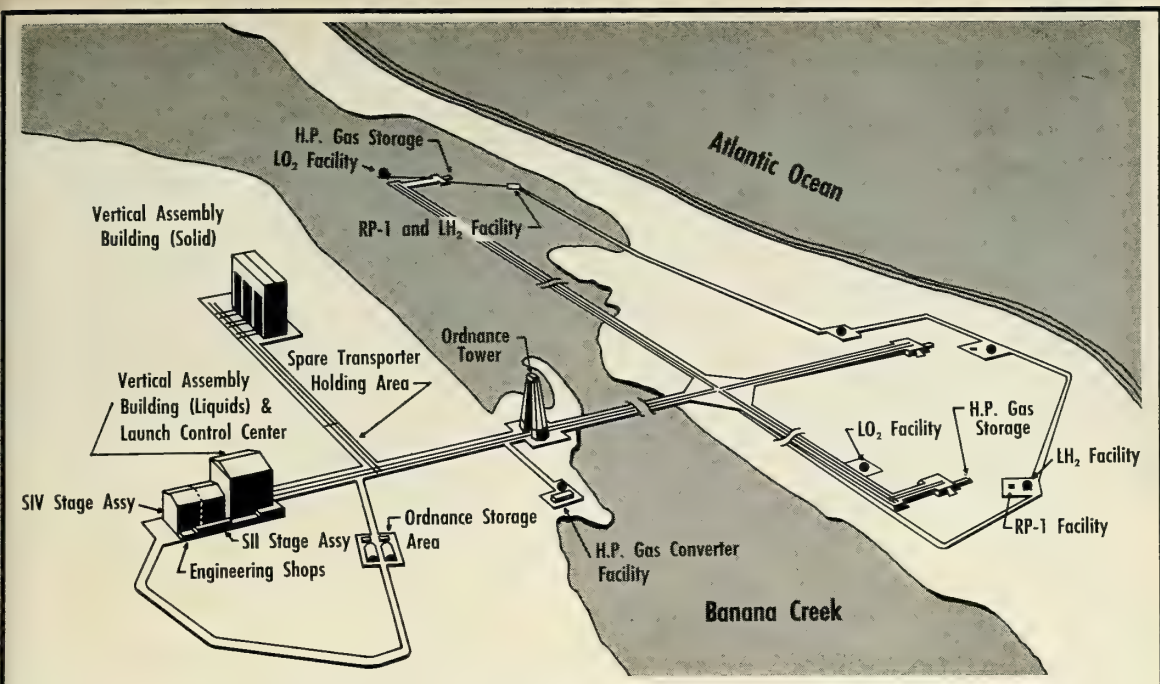
To meet its additional procurement needs, LOD is setting up its own procurement office. This had been handled earlier by the Marshall Space Flight Center to which LOD reports.

• **Planning for C-4**—Top procurement officer in the new operation will be Gerard Michaud. His office will be awarding contracts for ground support equipment, research and development area, and facility support purchases. At present, the office has a small staff, but it may eventually employ approximately 50 persons to handle the procurement and contract negotiation for the giant *Saturn* pads on which construction will begin next year.

Plans and specifications for the giant pads were prepared by LOD under the direction of Maj. Rocco Petrone—a U.S. Army officer currently on duty with NASA.

So far, plans for the first *Saturn* pad are based on the premise that it would be used to launch the *Saturn* C-4 boosters, which would have four F-1 engines developing a total thrust in its





LOD DRAWING of planned Saturn C-4 launch complex with two to three pads. This version utilizes the rail transporter, but would not differ too much if the barge-canal transporter concept were selected (see sketch on p. 118).

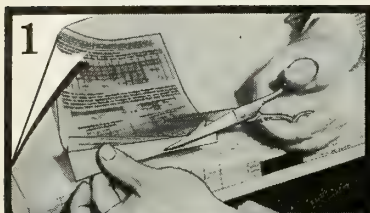
first stage of 6 million lbs.  
 LOD's specifications call for a *Saturn C-4* complex with three launch pads, which would be capable of 25 launches per year. Thus, the complex could easily handle the launch requirements of the "orbital rendezvous" concept of space flight. All of the proposed configurations for the second-generation *Saturn* vehicle are slated to play a role in "rendezvous" if it proves feasible.  
 Total cost of the complex is estimated by NASA officials at \$300 million to \$500 million.

The most imposing structure will be the 450-ft.-tall Vertical Assembly Building. According to current plans, it will have six bays in which the giant *Saturn* vehicles will be assembled and checked out. LOD has also made tentative provisions for a large building in which large solid boosters can be prepared if they are tabbed for a role in the lunar program.  
 After checkout in the VAB, the launch vehicles will be moved to the launch pad, where an additional week's checking will take place.  
 • **Canals and Texas Towers**—Two methods are being considered by LOD. One would utilize a giant transporter on a rail line. The second method calls for the construction of a canal and a barge transporter.  
 LOD estimates that the barge-canal method would cost \$250,000 per mile and the rail version some \$4 million per mile. But the rail concept has cer-

tain advantages—including speed and more stability for the vehicle.  
 The rail bed will have to be capable of supporting 6 million pounds. Its transporter will be 150 ft. long and 90 ft. wide to handle the *C-4*'s planned 396-in. diameter. The transporter will have a 350-ft.-high umbilical tower for *C-4* launch and 20-ft.-long hold-down arms.  
 In the barge-canal concept, a Texas Tower would be utilized to jack up the barge 40 or 50 ft. It is also possible that a lock in the canal could be used to boost the barge up to the height of the pad. The barge-transporter would be 150 ft. long and 110 ft. wide.  
 In both plans the transporter and the umbilical tower are the core of the system because the vehicle will be fired from them. Each of them will contain all the electronic GSE needed for a launch operation.  
 As soon as a final decision is made on specifications for the *Saturn* facility, LOD officials said, architectural and GSE design work will begin. Contractors may be asked for proposals late next year. No one contractor is expected to get the GSE work.  
 This fast schedule will not apply to the launch pads for the giant *Nova* booster which will develop a total first-stage thrust of from 12 million to 20 million lbs. thrust.  
 Total cost of three *Nova* pads will be well over \$500 million and may approach \$1 billion. Each pad will be

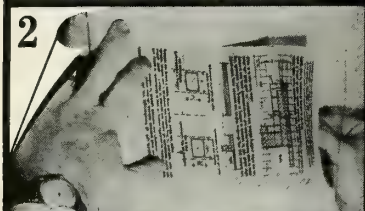
capable of eight launches per year.  
 The *Nova* gantry for each pad will be 450 ft. high and 20 ft. square at the base. The vehicle will be assembled and checked out on the pad. Because of the gantry's immense size, it will be immovable; the booster will have to be fired through it. The gantry's sides will be lowered to permit exhaust gases to escape.  
 The vehicles will be moved to the gantry on large barges which will also be used as the launch pad. Upper stages will be transported by rail and a crane will be used to place them on the first stage.  
 • **Spaceport buildings**—Besides the electronic GSE which will be needed for both launch complexes, liquid hydrogen-liquid oxygen storage tanks with a capacity of 500,000 gallons each and facilities for such high-pressure gases as helium and nitrogen will be needed.  
 The launch pads are only part of the story. Other buildings—requiring millions of dollars of equipment and instrumentation—which will be built at Cape Canaveral include:  
 —An engineering and administrative building.  
 —A spacecraft assembly building which will be able to assemble and check out two *Apollo* spacecraft at one time.  
 —A building to be used for the testing of various explosives used in the spacecraft system.  
 —Quite possibly, a cryogenics man-

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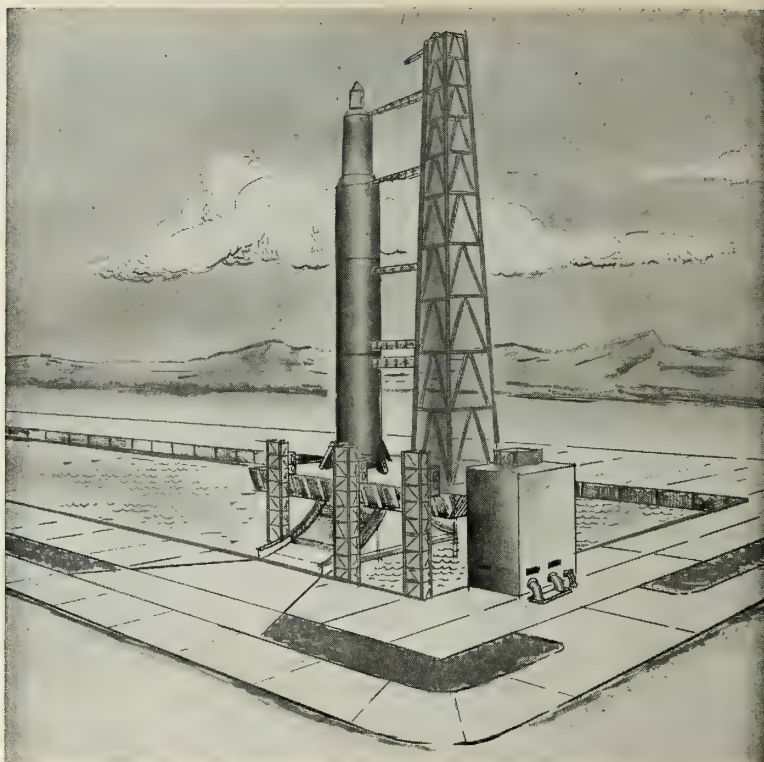
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*LOD'S CONCEPT of how a barge would be used to launch a Saturn C-4. The barge transporter under consideration would be 150 ft. long and 110 ft. wide.*

ufacturing and storage building.

In addition to the vast GSE procurement and launch pad construction, LOD's other main function—besides the launching of vehicles with their payloads—will be in the area of research and development.

Among the major areas and problems which will be explored are:

- Better ways of receiving data from the booster before and during launch.

- Use of a water injection technique to cut the terrific noise level problem for instrumentation and equipment which will result from the *Saturn C-4* and *Nova* development.

- Better firefighting methods during launch operations.

- Problems in swinging and moving the heavy masses of the umbilical tower on the *Saturn C-4* pad.

- Blast effects of liquid hydrogen-liquid oxygen and similar studies of RP-1 and liquid oxygen.

- Making canal transportation smoother.

- The problems of long-distance digital transmission from the vehicle to the Vertical Assembly Building.

LOD's primary role is to provide the launch capability for the Marshall Space Flight Center. It also makes de-

sign inputs when the launch range limitations may influence a launch vehicle configuration, and provides support services for other NASA installation personnel who are working at the Cape.

LOD's director is Dr. Kurt Debus, whose official title is Director of the Marshall Space Flight Center's Launch Operations Directorate. He reports directly to Marshall's director, Dr. Werner von Braun.

Debus' chief assistant is Dr. Gruen Major Petrone is responsible for LOD's manned lunar landing activities.

An organization chart for LOD is not available at this time, because it is undergoing revision.

There has also been some consideration of a proposal to make LOD a self-supporting center which would report directly to NASA headquarters.

Best bet is that LOD will be relieved of its current responsibility for the construction of facilities to be used by personnel from other NASA centers. Instead, the various centers will be responsible for their own construction at Cape Canaveral, with LOD having master planning control.

At the Pacific Missile Range—which LOD also runs—the construction authority probably will be given to the Goddard Space Flight Laboratory. ■



# Wallops to Grow Slightly—If at All

**WALLOPS STATION** — NASA's launch site for most of its sounding rockets and small scientific satellites—will be only marginally affected by the expansion of the overall space program. Following the limited expansion programed for this fiscal year, the overall budget of Wallops should remain relatively constant and may actually decline as presently planned facilities are finished.

In terms of procurement dollars, this NASA facility presents little potential to industry. All of its contract awards are on a fixed-price basis and consist of well-defined, specified electronics systems or housekeeping services.

To fulfill its mission of launching scientific experiments and gathering data from these payloads, Wallops has a total

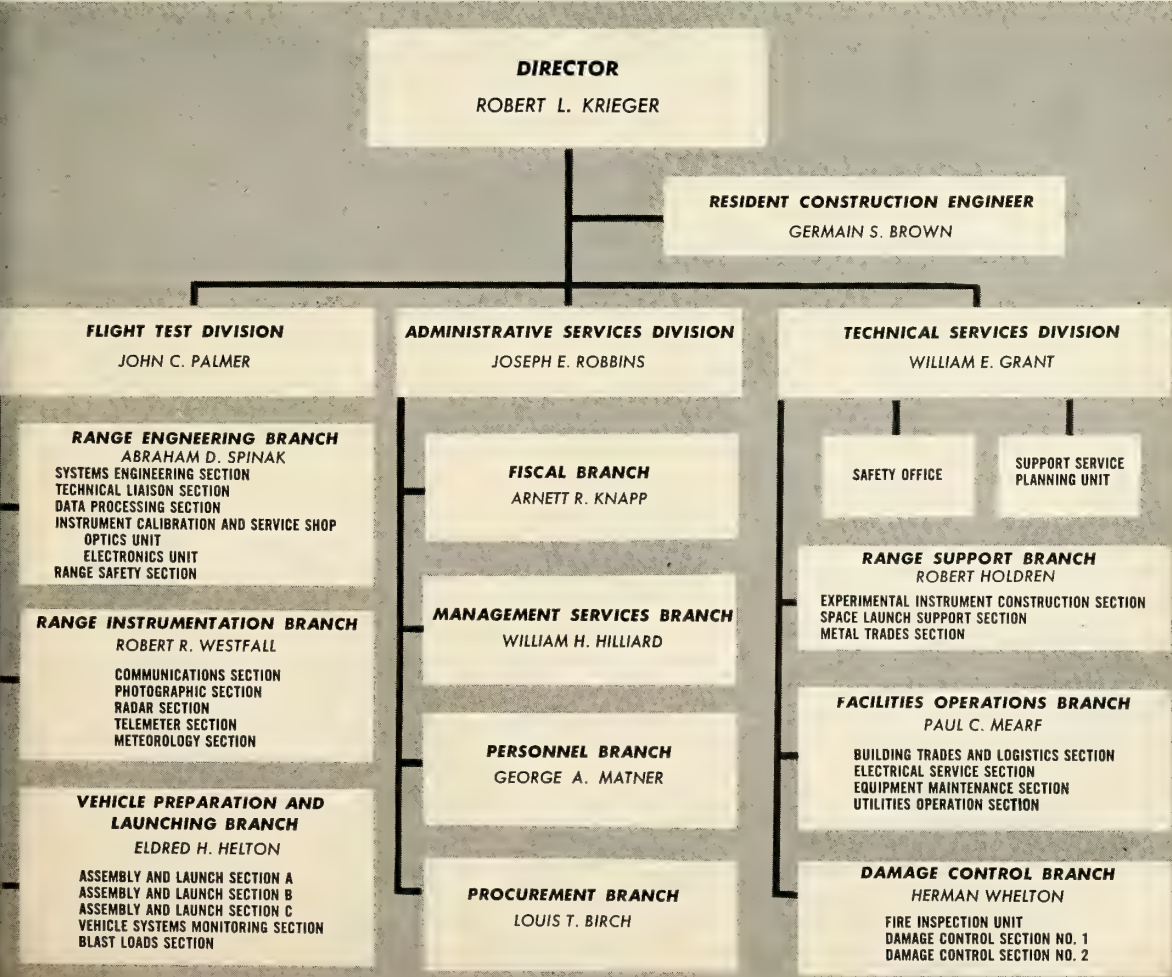
Fiscal Year '62 budget of approximately \$14 million. Of this, \$3.8 million is for salaries and expenses, \$4.0 million for support of the plant and operations and \$6.3 million for updating and construction of facilities. The total complement for the station is scheduled to increase during this fiscal year from 299 persons to 399. Much of this increase has already taken place and employment at Wallops stands at a little more than 346.

- **Facilities available**—Wallops Station actually consists of three separate pieces of real estate. The first is the Main Base—formerly the Chincoteague Naval Air Station—housing the administrative and management groups as well as those technical services and shops not essential to launch operations. Also in this area is a prototype *Mercury*

tracking station and the East Coast readout station for the *Tiros* meteorological satellites.

On approximately 100 acres of the mainland opposite the Wallops Island launching facilities are three 60-foot antennas. Two of these are operated by the Massachusetts Institute of Technology for studies of re-entry physics. The third—operated by Wallops personnel—is used to track the scientific payloads launched from Wallops Island.

Located on a sandy island off the Virginia coast are the five launch areas, the assembly and checkout buildings and the requisite blockhouses. At the southern limit of the launch area is the launch area and associated facilities for firing the *Aerobee*. Moving north, the next area consists of five extremely simple



launchers for small probe rockets, ranging from a 5-stage rocket system using an *Honest John* motor for the first stage to a small rocket for launching models.

Probably the most elaborate and expensive facility is the *Scout* launch area with its 105-foot, enclosed gantry and reinforced concrete-earth blockhouse.

The two remaining launch sites—*Little Joe* and *Trailblazer*—consist of simple concrete pads, fixed camera locations, terminal power and communications facilities and the launchers themselves. The *Scout* blockhouse is equipped to check out, monitor and fire vehicles from these pads.

• **Programs, present and future**—Since Wallops does not originate any

programs, it is primarily concerned with updating and keeping in good repair the launch facilities necessary to satisfy user requirements. During the current fiscal year, for example, approximately two-thirds of its construction money will be spent to update its tracking facilities to meet the demands for near real-time data display. This improved tracking capability will increase the reliability, performance, precision and range of the existing AN/FPS-16 and Mod II radar tracking systems.

• **Procurement policy**—A fixed-price contract policy is possible, according to Wallops officials, because procurement is based on general performance specifications for a specific piece

of equipment or on past experience with range service requirements.

The main areas of procurement interest are electronic equipment, particularly digital systems, electronic parts and repair and housekeeping services essential to the Wallops mission. Louis T. Birch is the station's procurement officer.

A firm interested in doing business with Wallops, according to station officials, should first write to Wallops outlining its capabilities and areas of interest. Then fill out a standard NASA Form 129 to apply for inclusion on the bidders' list and, finally, since Wallops has a limited procurement staff, make an appointment to visit the installation. ■

## NASA INDUSTRY GUIDE

# PMR Has Modest Launching Program

**Bulk of Test Support Office's \$1-2-million FY 1962 budget is earmarked for a new Scout site; small staff plays important role in coordinating numerous phases of missions**

ONLY A VERY SMALL portion of NASA's total space activity is carried on at the Pacific Missile Range.

Just 11 NASA launchings are scheduled from this facility through 1964. Funding for the space agency's Test Support Office (TSO) at PMR for FY '62 will be between \$1 and 2 million, mostly for construction of a *Scout* launch site at Point Arguello.

NASA's entire plant investment at Point Mugu and Arguello currently amounts to about \$3 million. Some expansion is indicated for the new *Scout* site. Also at Arguello, NASA will spend about \$325,000 to modify a portion of the missile assembly building for space vehicle applications.

Another \$300,000 will be spent modifying a *Thor* launch site (75-1) at Vandenberg AFB, formerly used for crew training and *Discoverer*-series firings, for use in NASA *Thor-Agena B* tests.

Other major existing NASA installations at PMR are the *Tiros* command and readout station; *Mercury* tracking station at Kokee Park, Hawaii, and Canton Island; and the *Mercury* command station at Point Arguello. The latter installation represents about a \$1-million investment, including an FPS-16 5000-mile tracking radar.

• **Small but vital**—Though small in staff (11 persons) and in budget, the TSO acts in support of several important NASA programs. First NASA

launch from PMR was *Nerva* (Nuclear Emulsion Recovery Vehicle) in 1960. Most recent was the successful *BIOS I* launching this month. Firings scheduled for TSO support in the future include Projects *Nimbus* and *POGO*, and second-generation *Echo* satellites—all involving the *Thor-Agena B* combination.

For most launches, a specialized team is sent on temporary assignment to augment the small TSO staff. In the case of Project *Mercury*, for example, a seven-man team from the Space Task Group monitors operation of the *Mercury* installations.

TSO is not independent—the staff is directly responsible to the Marshall SFC Launch Operations Directorate. Systems manager for TSO at PMR is Cdr. S. J. Burttschell, a Naval aviator with considerable missile experience on assignment to NASA. Cdr. Burttschell is responsible for final coordination of all NASA launch activities at PMR.

Because of its close ties to Marshall, the support office makes few local purchases. PMR makes those that do not exceed \$25,000. Whenever possible, major facilities are authorized by Marshall or directly by NASA headquarters, in accordance with PMR's master plan and multiple-use concept. Contracting of this nature is handled through the Navy's Bureau of Yards and Docks.

A major problem for TSO/PMR and Marshall is formation of program decisions within the normal budget cycle

of PMR. When NASA requirements can be delineated in time, the needed funds can be included in PMR's budget. In the event of a program change or special requirement (such as the installation of the Point Arguello *Mercury* station), NASA must pay for the facility from its own program funds.

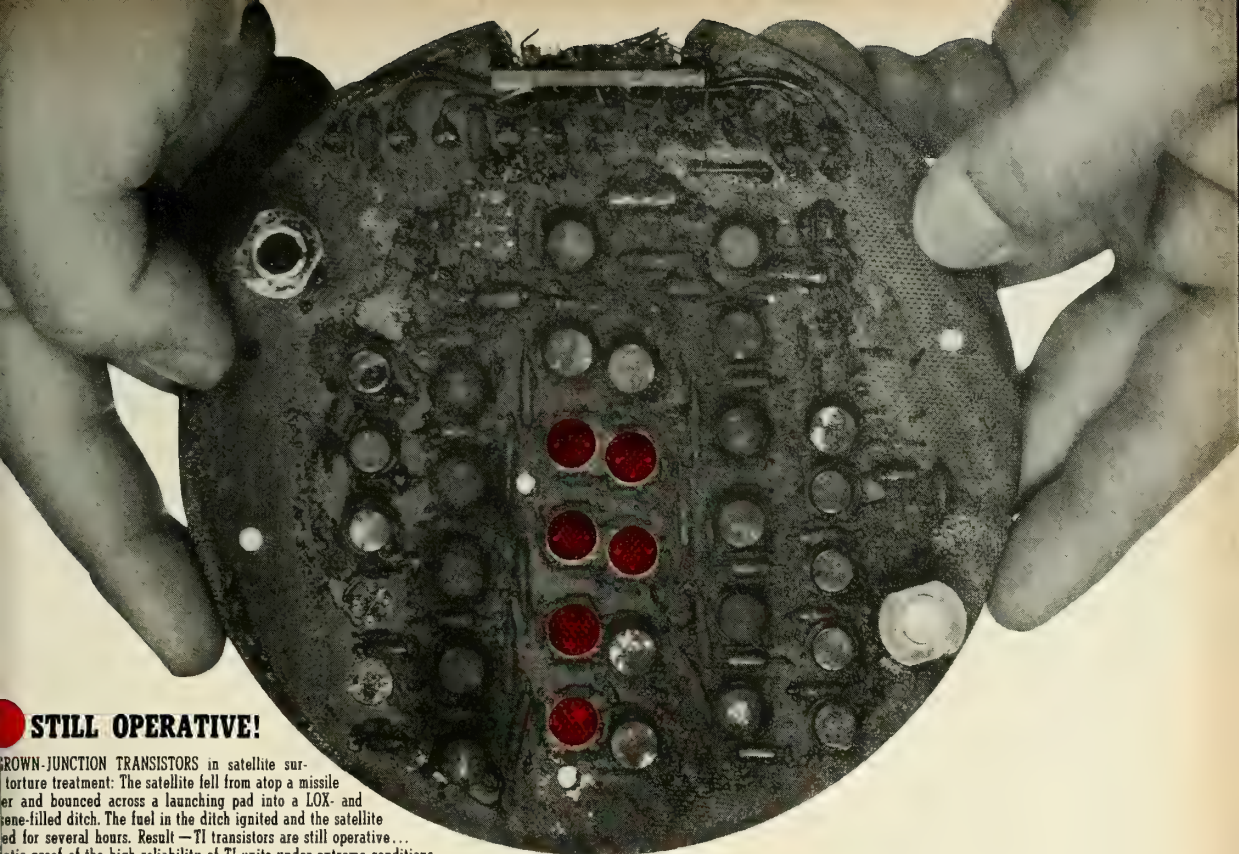
• **Prime example**—Perhaps the best illustration of TSO functions was the recent *BIOS I* launching. In this shot, the TSO was involved with almost every major NASA division.

Project management was the responsibility of Goddard SFC; bioscience system management by Ames Research Center; physical science system management and launch vehicle system management by the Launch Operations Directorate, Marshall SFC.

To further break down this "one-shot" operation, there was also direction from NASA headquarters. The Office of Life Sciences Programs established requirements for *BIOS* and overall project direction. The Office of Space Flight Programs implemented the program through Goddard. The Office of Launch Vehicle Programs implemented launch, tracking, and recovery operations through Marshall, and the Office of Advanced Research Programs implemented bioscience experiments through Ames.

Actual coordination of all program phases for mission execution was handled by TSO. ■





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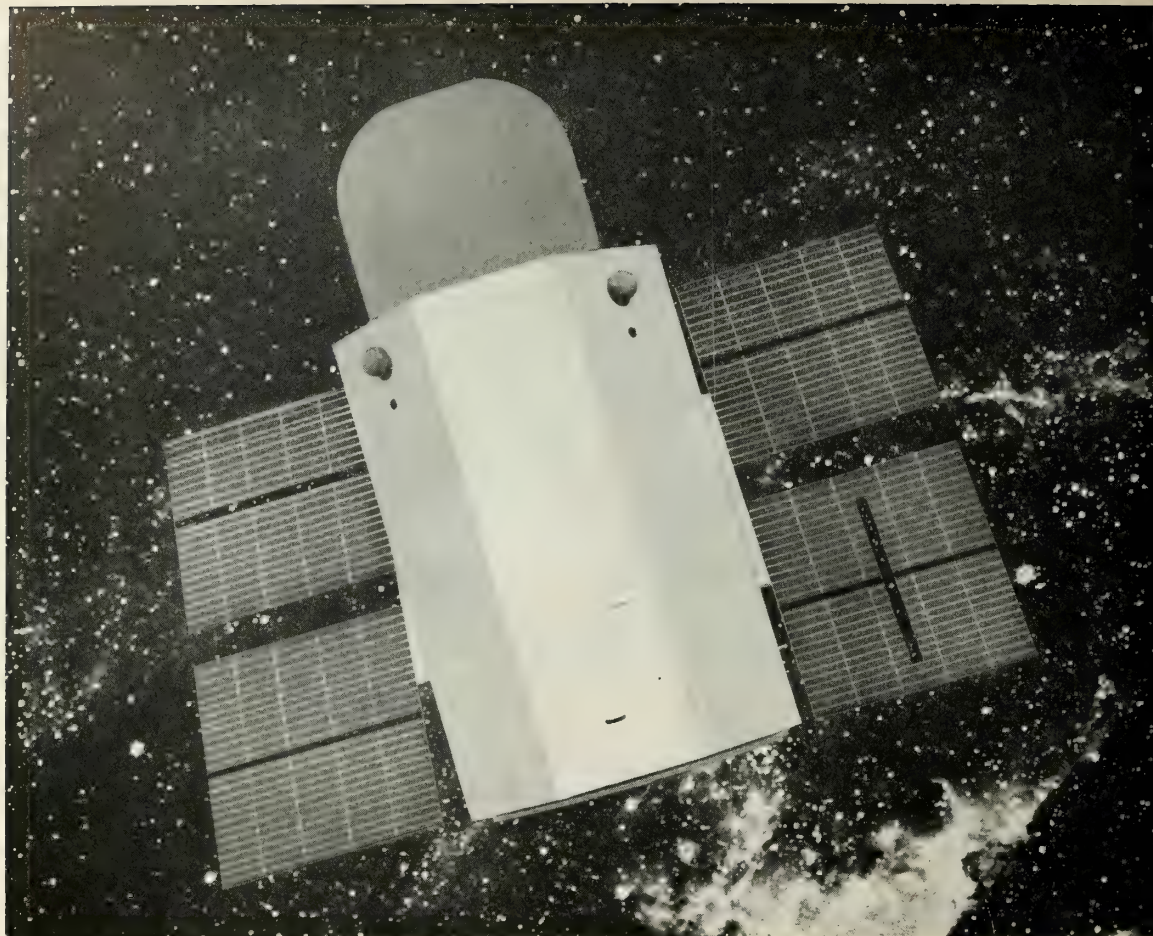
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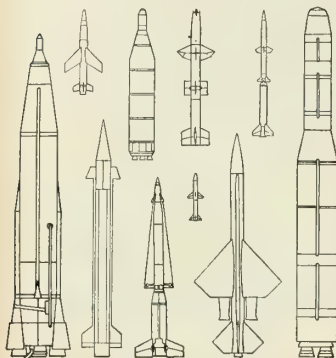
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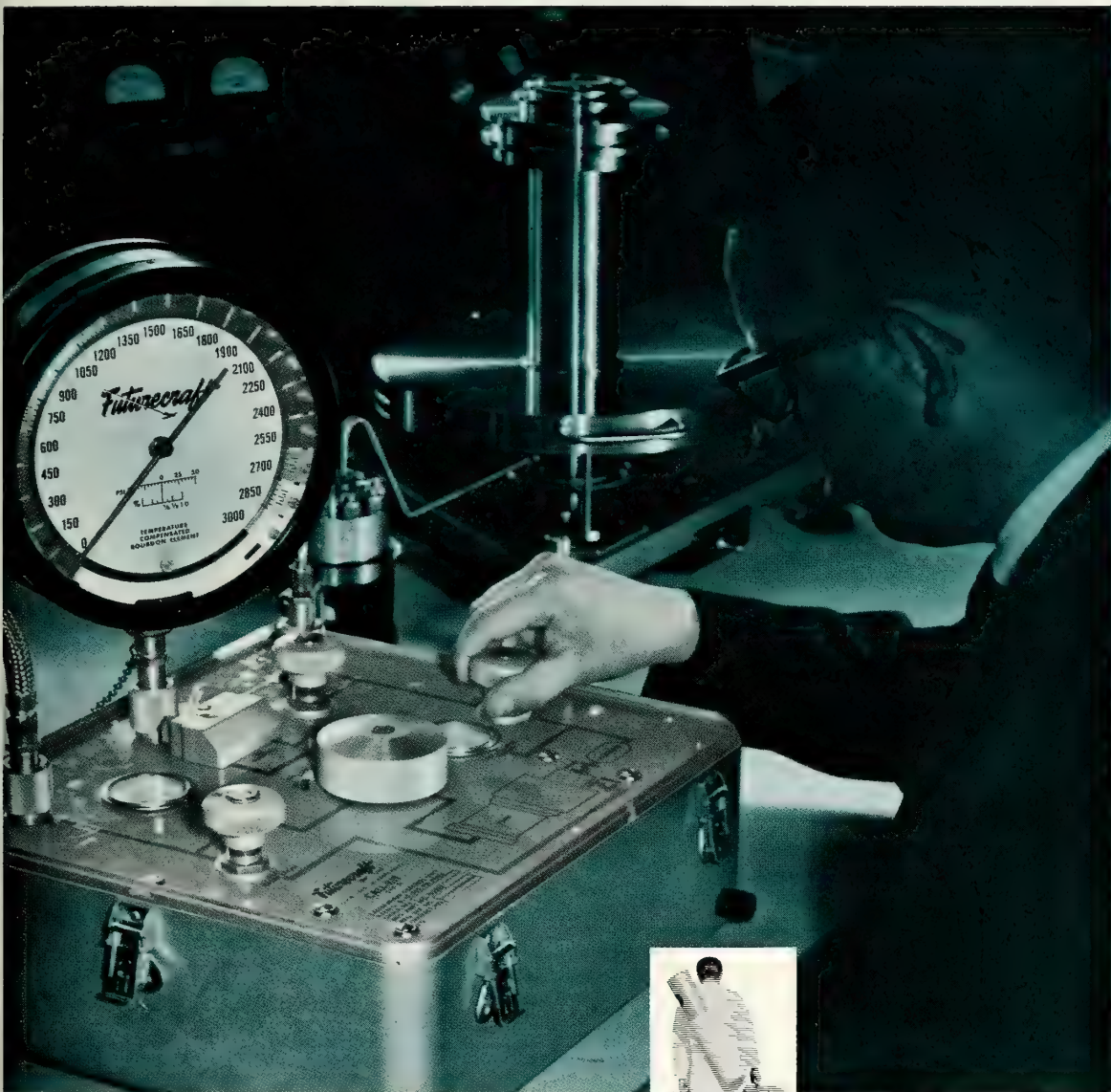
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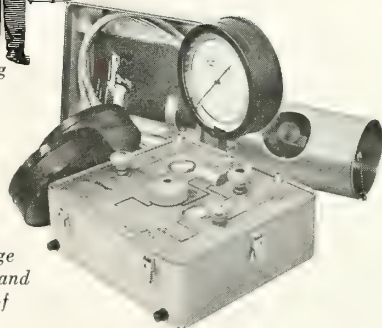




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| Alloy Name     | NOMINAL CHEMICAL COMPOSITION |     |      |                                               |     |      |     |     |     |      |     | Fe       | Others |  |
|                | C                            | Mn  | Cr   | Ni                                            | Co  | Mo   | W   | Ti  | Al  | B    |     |          |        |  |
| 19-9DL         | .30                          | 1.0 | 19   | 9                                             | ..  | 1.4  | 1.3 | .3  | ... | ...  | 66  | .4 Cb    |        |  |
| 19-9DX         | .30                          | 1.0 | 19   | 9                                             | ..  | 1.6  | 1.3 | .6  | ... | ...  | 66  | ...      |        |  |
| AF-71          | .30                          | 18  | 12.5 | ...                                           | ... | 3    | ... | ... | ... | ...  | 73  | .2N, .9V |        |  |
| A-286          | .05                          | 1.4 | 15   | 26                                            | ..  | 1.25 | ... | 2.2 | .2  | .003 | 54  | .3 V     |        |  |
| Discaloy       | .05                          | .6  | 13   | 26                                            | ..  | 3    | ... | 2   | .2  | ...  | 54  | ...      |        |  |
| G-192          | .60                          | 8.5 | 22   | ...                                           | ... | ...  | ... | ... | ... | ...  | 69  | .35 N    |        |  |
| V-57           | .06                          | .25 | 15   | 26                                            | ..  | 1.3  | ... | 3   | .2  | .008 | 54  | .2 V     |        |  |
| D-979          | .05                          | .6  | 15   | 45                                            | ..  | 4    | 4   | 3   | 1   | .01  | 27  | .....    |        |  |
| AL 901         | .05                          | .25 | 13   | 43                                            | ..  | 6    | ... | 2.9 | .2  | .015 | 35  | .03 Zr   |        |  |
| Waspaloy       | .05                          | .3  | 19   | 56                                            | 14  | 4    | ... | 3.0 | 1.3 | .005 | 1   | .....    |        |  |
| M-252          | .15                          | .5  | 19   | 55                                            | 10  | 10   | ... | 2.5 | 1   | .005 | 2   | .....    |        |  |
| R41            | .10                          | .3  | 19   | 53                                            | 11  | 10   | ... | 3.2 | 1.6 | .005 | 2   | .....    |        |  |
| S-590          | .43                          | 1.2 | 20   | 20                                            | 20  | 4    | 4   | ... | ... | ...  | 29  | 4 Cb     |        |  |
| N-155          | .15                          | 1.5 | 21   | 20                                            | 20  | 3    | 2.5 | ... | ... | ...  | 32  | 1 Cb     |        |  |
| S-816          | .40                          | 1.2 | 20   | 20                                            | 44  | 4    | 4   | ... | ... | ...  | 3   | 4 Cb     |        |  |
| V-36           | .30                          | 1   | 25   | 20                                            | 42  | 4    | 2   | ... | ... | ...  | 3   | 2 Cb     |        |  |
| L-605          | .15                          | 1.5 | 20   | 10                                            | 53  | .... | 15  | ... | ... | ...  | ... | ...      |        |  |

*Letters names listed above are trademarks of companies other than Allegheny Ludlum Steel Corporation*

A number of the names listed above are trademarks of companies other than Allegheny Ludlum Steel Corporation



### REFERENCE DATA

Compiled by  
ALLEGHENY LUDLUM STEEL CORPORATION  
Oliver Building • Pittsburgh 22, Pennsylvania

| Alloy Name | Density<br>lb./in. <sup>3</sup> | 100-Hr. Rupture Strength at |              |              |              | Short Time Properties |             |                    |             |
|------------|---------------------------------|-----------------------------|--------------|--------------|--------------|-----------------------|-------------|--------------------|-------------|
|            |                                 | 1200F                       | 1350F        | 1500F        | 1600F        | Room Temperature      |             | 1200 F             |             |
|            |                                 | (X 1000 Psi)                | (X 1000 Psi) | (X 1000 Psi) | (X 1000 Psi) | TS<br>(X 1000 Psi)    | Elong.<br>% | TS<br>(X 1000 Psi) | Elong.<br>% |
| 19-9DL     | .287                            | 52                          | 28           | 17           | ...          | 118                   | 69          | 75                 | 37          |
| 19-9DX     | .287                            | 52                          | 28           | 17           | ...          | 118                   | 69          | 75                 | 37          |
| AF-71      | .280                            | 69                          | 40           | 22           | ...          | 150                   | 110         | 90                 | 77          |
| A-286      | .286                            | 63                          | 35           | 15           | ...          | 152                   | 110         | 115                | 87          |
| Discaloy   | .288                            | 55                          | 32           | 15           | ...          | 147                   | 92          | 100                | 77          |
| G-192      | .278                            | 42                          | 27           | 15           | ...          | 148                   | 85          | 92                 | 37          |
| V-57       | .286                            | 75                          | 40           | 15           | ...          | 172                   | 119         | 129                | 108         |
| D-979      | .296                            | 94                          | 63           | 35           | 21           | 200                   | 143         | 123                | 17          |
| AL 901     | .294                            | 90                          | 60           | 20           | ...          | 175                   | 125         | 145                | 110         |
| Waspaloy   | .294                            | 98                          | 65           | 39           | 24           | 185                   | 130         | 160                | 120         |
| M-252      | .298                            | 95                          | 62           | 35           | 20           | 180                   | 122         | 155                | 110         |
| R 41       | .296                            | 100                         | 67           | 44           | 28           | 200                   | 150         | 160                | 130         |
| S-590      | .301                            | 50                          | 32           | 18           | 13           | 75                    | 20          | 97                 | 70          |
| N-155      | .297                            | 50                          | 31           | 18           | 12           | 58                    | 40          | 80                 | 43          |
| S-816      | .313                            | 60                          | 38           | 25           | 16           | 72                    | 35          | 115                | 55          |
| V-36       | .303                            | 64                          | 35           | 25           | 18           | 67                    | 55          | 95                 | 40          |
| L-605      | .330                            | 70                          | 43           | 24           | 15           | 70                    | 50          | 98                 | 48          |

Properties listed above are typical, and should not be used as specification minima



# Mar-Aging Steels...with yields over 250,000 psi PLUS toughness!

NOMINAL COMPOSITION OF MAR-AGING STEELS

|                      | C   | Ni | Co | Mo | Ti  | Al | Cb |
|----------------------|-----|----|----|----|-----|----|----|
| AL 25 Ni (250)       | .01 | 25 | .. | .. | 1.4 | .2 | .5 |
| AL 20 Ni (250)       | .01 | 20 | .. | .. | 1.4 | .2 | .5 |
| AL 18 Ni Co Mo (250) | .01 | 18 | 7  | 5  | .4  | .1 | .. |
| AL 18 Ni Co Mo (300) | .01 | 18 | 9  | 5  | .6  | .1 | .. |

Looking for "special" properties even in the special steels? Take a look at the Mar-Aging Steels, a brand new group of high alloy, precipitation-hardening steels offering unmatched toughness and the strength of the best contemporary steels. Here are a few interesting properties ... yield strengths exceeding 250,000 psi ... notched tensile strengths over 400,000 psi ... and the ability to maintain ductile properties below -80 F.

Discovered by International Nickel Company, developed and being produced by Allegheny Ludlum, the Mar-Aging steels achieve their high strength by means of an extremely simple heat treatment. Remarkably resistant to crack propagation, the Mar-Aging Steels are easily machinable, easy to weld, and possess unusually low work-hardening characteristics.

Available in all product forms, the Mar-Aging Steels may be air melted, or vacuum melted for maximum notch toughness and transverse ductility.

TYPICAL MECHANICAL PROPERTIES OF MAR-AGING STEELS

| PRODUCTS                                | .2 YS<br>(X 1000 psi) | UTS | Elong.<br>% | RA<br>% | Notch TS<br>Smooth TS |
|-----------------------------------------|-----------------------|-----|-------------|---------|-----------------------|
| <b>BARS</b><br>(Heat treated)           |                       |     |             |         |                       |
| AL 25 Ni (250)                          | 250                   | 265 | 12          | 50      | 1.1                   |
| AL 20 Ni (250)                          | 250                   | 265 | 12          | 55      | 1.3                   |
| AL 18 Ni Co Mo (250)                    | 250                   | 265 | 10          | 50      | 1.5                   |
| AL 18 Ni Co Mo (300)                    | 300                   | 305 | 12          | 55      | 1.4                   |
| <b>SHEETS</b><br>(Cold rolled and aged) |                       |     |             |         |                       |
| AL 25 Ni (250)                          | 250                   | 270 | 5           | ..      | .7                    |
| AL 20 Ni (250)                          | 260                   | 270 | 4           | ..      | .7                    |
| AL 18 Ni Co Mo (250)                    | 285                   | 290 | 4           | ..      | .9                    |
| AL 18 Ni Co Mo (300)                    | 300                   | 310 | 3           | ..      | .8                    |

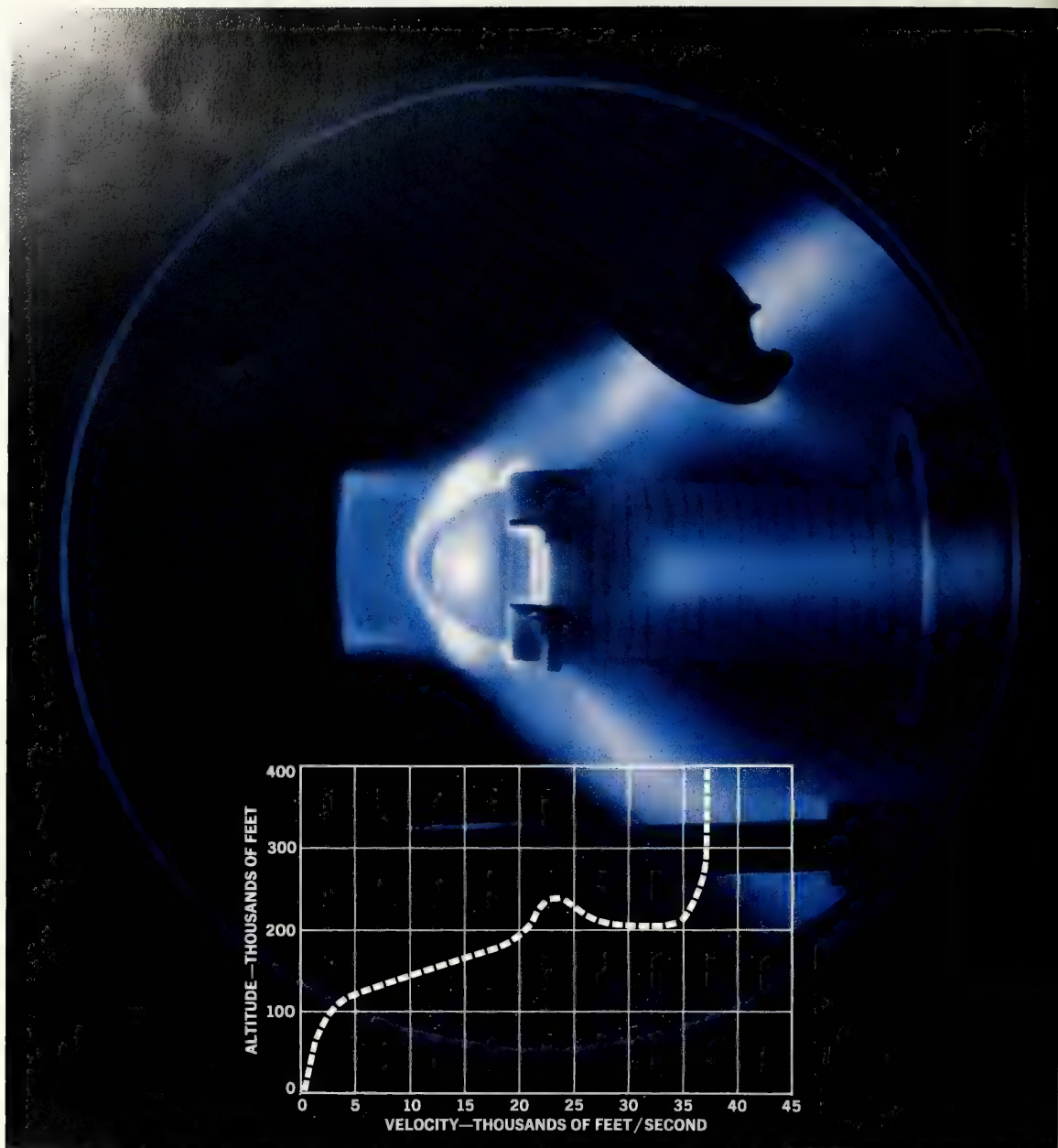
Together with A-L's family of famous stainless steels (all grades—all mill forms), low alloy-high strength steels, tool steels, bearing steels, and high temperature steels and alloys, the Mar-Aging Steels make the Allegheny Ludlum product line one of the most comprehensive offered to the aircraft and missile industries. And to assist in applying this family of steels, A-L offers customer contact service at any level in your organization, including in-plant teamwork with your specialists on your problems. Add the support of the A-L research organization, and technical literature written in *your* language, and you have the famous Allegheny Ludlum service.

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## NEW A-L LITERATURE

A new series of technical booklets on A-L High Temperature Alloys is yours for the asking. Each is packed with data to assist design engineers and procurement specialists in selecting materials for any high strength-high temperature application.

And be sure to get your request in early for the new Data Sheet on Mar-Aging Steels. Contact your local A-L Representative, today. Or write: Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address: Dept. MID 6.



## Taking a new look at manned re-entry

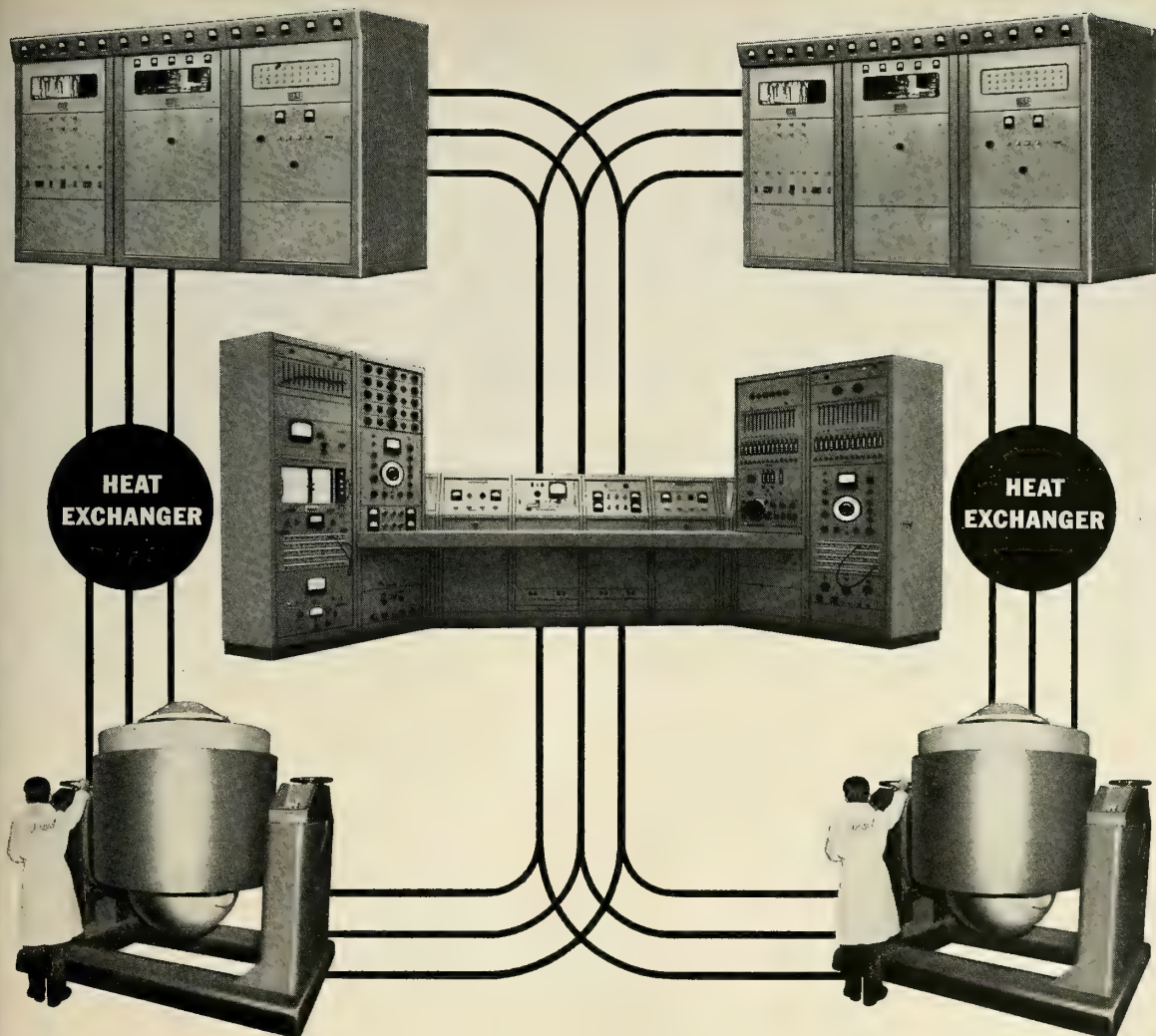
The Avco Orbital Vehicle Re-entry Simulator, called OVERS, makes possible long-duration programmed simulation of the stagnation pressures, enthalpies and heat fluxes characteristic of re-entry from manned orbital and superorbital trajectories. Air enthalpies typical of lunar probe re-entry are being obtained. A new generation of simulators is pres-

ently under development for programming re-entry of interplanetary probes. The OVERS and other advanced facilities for long-duration re-entry simulation are slated for the new 80,000-sq.-ft. Space Sciences Laboratory now under construction at AVCO'S RESEARCH and ADVANCED DEVELOPMENT DIVISION, Wilmington, Massachusetts.

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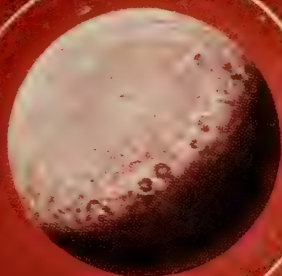
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A space rendezvous system • Nuclear and other advanced propulsion systems  
Communications satellite systems.

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# Langley to Maintain R&D Leadership

MODERATE BUT STEADY expansion is the forecast for NASA's oldest research center, at Langley, Va.

Authorizations for plant modernization and new facilities over the Fiscal 1961-62 period total nearly \$45 million. Improvements are expected to assure the center's continued leadership in materials and structures research and development for the space agency.

One-third of Langley Research Center's 3000-plus employees are scientists and engineers. Indicative of the in-house capability here is the relatively small outlay in contracts to industry for basic research—only \$5 million out of a total of \$60 million authorized for R&D. The rest goes for hardware procurement, including \$30 million for *Scout* launch vehicles.

It is significant that Langley has served as a reservoir for highly skilled specialists from which the government has drawn over and over again to form new research facilities. Cadre for four research centers—Ames, Lewis, Wallops Station, and the Flight Research Center at Edwards AFB—were first provided by Langley.

Established nearly 45 years ago, this center has been involved with virtually every type of aircraft, missile and spacecraft built or presently conceived. When the first Mach-3 air transport or the *Apollo* or *Dyna-Soar* leaves earth, it will be due in no small measure to the research being performed here today.

• **Major programs**—By far the greatest research effort at Langley is the broad study of structures and advanced materials, a field in which it is considered the major NASA center. Scientists here wage a continuous many-pronged attack on high-temperature problems of re-entry.

In their Flight Re-entry Program, researchers will obtain flight verification of heating problems on typical lunar return vehicles. In general, the tests involved cannot be performed with ground facilities.

Five-stage *Scout* launch vehicles will be used to approach speeds up to 30,000 ft./sec. Three different payloads are now being built to study (1) total heat (convective and radiative), (2)



FLOYD L. THOMPSON  
Director of Langley Research Center

separate radiative components, and (3) heat-shield materials.

In cooperation with Lincoln Laboratory of Massachusetts Institute of Technology, the Center has been concerned for the past 2½ years with the Trailblazer program. Primarily, this is a signature study of ICBM trails during re-entry. The Trailblazer vehicle employs six stages—three for vertical boost upward, three for downward.

The program has been extended to relate mass and light intensity for media determinations up to 200 miles altitude.

Using the six-stage vehicle, velocities up to 23,000 ft./sec. have been achieved. A seven-stage vehicle also has been employed to fire a dime-size steel projectile to 37,000 ft./sec.

Other principal programs include:

—Development of the NASA *Scout* launch vehicle (since 1958).

—Design and development of *Echo* passive communications satellites. Follow-on to *Echo I* is the rigidized, 135-ft.-diameter *Echo II* now in final development. Langley is responsible for program contracting, as well as satellite and payload design.

—Coordination of instrumentation supplied by other NASA centers for the micrometeoroid-satellite program and for all the final payloads.

—Fundamental investigations of plasmas and plasma motions.

In addition to these and other smaller programs for which Langley has prime responsibility, the center also conducts basic research to support other centers.

• **Langley facilities extensive**—Over its 710 acres, Langley has planted more than \$150 million worth of laboratories, shops, support facilities, and more than 40 major wind tunnels.

Ground facilities are supplemented by free-flight research facilities including use of full-scale aircraft and vehicles launched by rocket from Wallops Island on Virginia's Eastern Shore.

Tunnels range in size all the way up to one having a 30x60-ft. cross section. Velocities obtainable vary from low-speed to Mach-30 in the Langley helium tunnel.

Hot-jet research facilities include one with a temperature capability reaching 16,000°F for re-entry simulation. A 10,000-kva power supply is used with the arc-jet systems.

A Langley-developed combined-load machine is believed to be the only facility of its type in the world. It can apply combinations of loads and moments which include up to a 250,000-lb. axial load, 2.5 million-in.-lb. torsion load, and a 3 million-in.-lb. bending load.

Other major facilities include landing-load track (for aircraft tests), vehicle control and lunar-landing simulators, and a 1.2-million-lb.-capacity hydraulic testing machine (for specimens up to 6 ft. wide x 18 ft. long).

Important new facilities authorized in design and construction include:

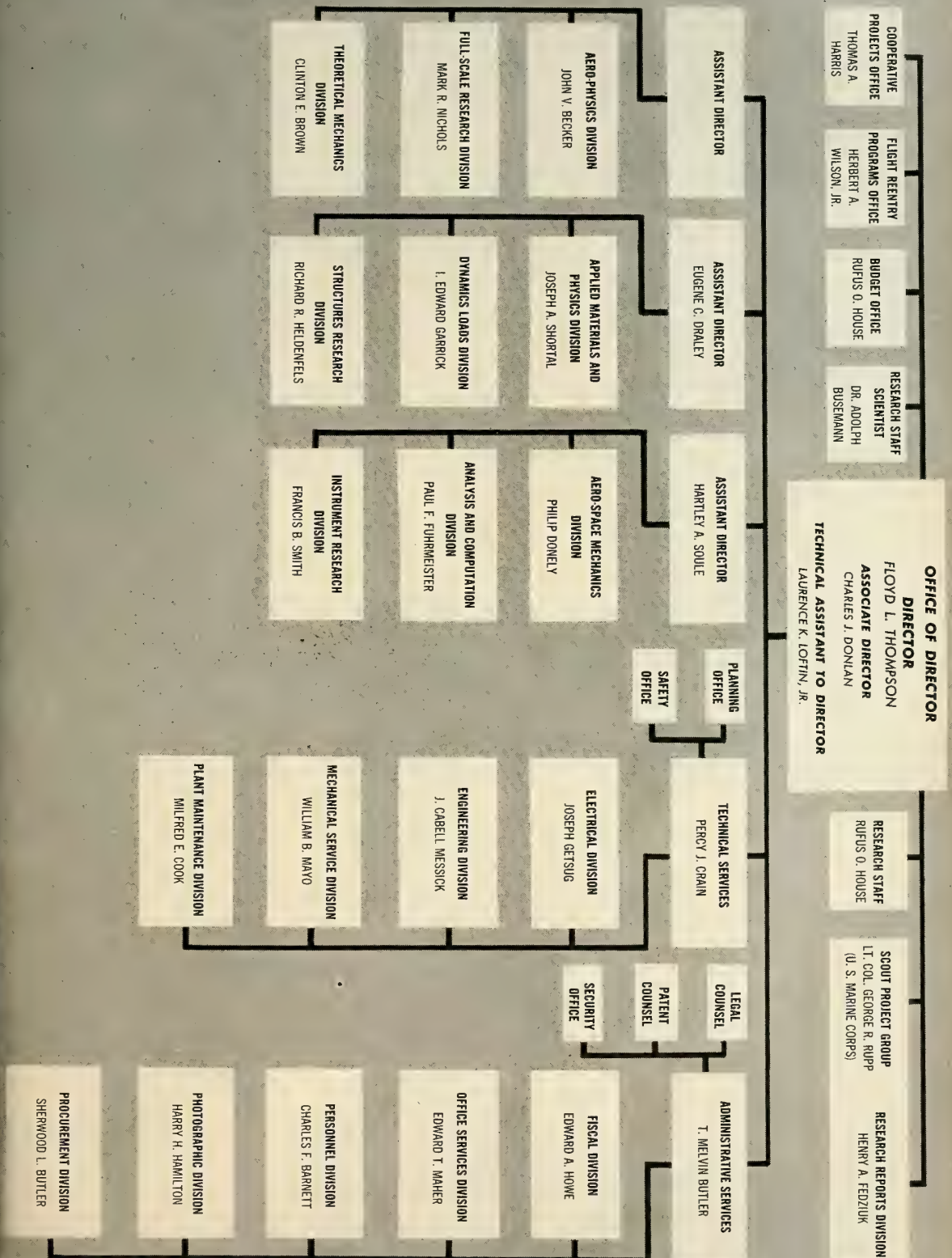
—A Dynamics Research Laboratory (to study dynamics problems on boosters, spacecraft, etc., under true environmental conditions).

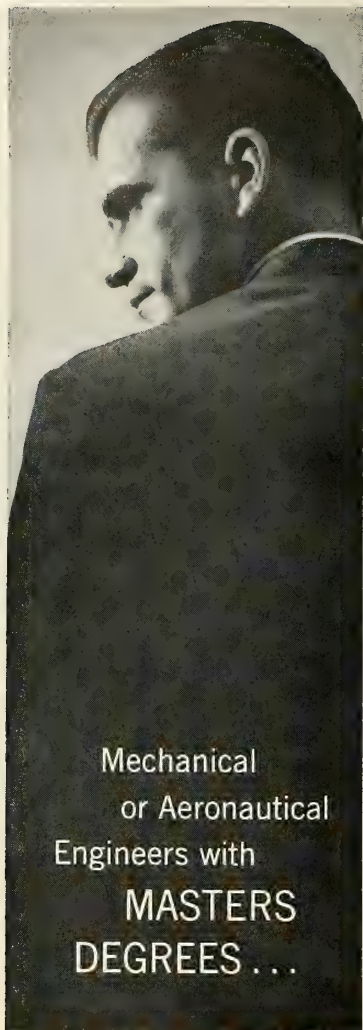
—A Hypersonic Aerothermal Dynamics Facility (to study hypersonic aerodynamic and aeroelastic problems under conditions of extreme temperature and velocity).

—An 8-foot-high, 4000°F temperature, Mach-7 structures research tunnel (to study problems of large test specimens under combined influence of aerodynamic loads and high temperature).

—A Lunar Landing Research Facility







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This program has strong corporate sponsorship with all that this implies in personal stability. Available are excellent experimental, computational, and library facilities with experienced supporting personnel. Attractive salary levels and benefits are available to qualified individuals.

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ity (to study stability, control, and instrument display problems of a man landing on the moon).

—A High-Intensity Noise Facility (to study the effect of noise on structures such as boosters).

—A Magnetoplasmadynamics complex. This includes a 10-megawatt arc tunnel now under construction that varies from 6 to 24 in. in diameter over its full length and will be capable of velocities as high as Mach 8.

• **Organization and responsibilities**

—Organizational structure of the Langley Research Center resembles that of a centralized industrial complex. Functionally, it is comparable to a typical industry research and development operation.

Director Floyd L. Thompson has two senior assistants, C. J. Donlan and L. K. Loftin, Jr. His office is also supported by the usual senior scientific, technical and administrative staffs.

Five major functional groups, consisting of 18 operating divisions, comprise the principal structure at the Center. In addition, three special projects—*Scout* development, Flight Re-entry, and Cooperative Projects—answer directly to Thompson's office.

The five major groups include Administrative Services, Technical Services, and three distinct R&D groups.

Project engineers for almost every task performed at the Center are drawn from the Engineering and Electrical Divisions of Technical Services. Prime concern of the Engineering Division is the engineering and design of research models and vehicles, research facilities, mechanical and chemical systems and controls. Electrical Division is concerned with electrical/electronic systems and subsystems design and engineering.

Each of the three R&D groups embraces three divisions and is headed by an assistant director.

The first, under John Stack, includes the Aero-Physics, Full-Scale Research, and Theoretical Mechanics Divisions. Principal efforts at Aero-Physics are in the areas of hypersonic vehicle performance, control, and stability; heat transfer and fluid dynamics; propulsion gas dynamics; magnetoplasmadynamics; space physics, re-entry phenomena and energy management, and advanced vehicle and mission analysis.

The evolution, improvement, and characteristics evaluation of aircraft, missiles, and spacecraft configurations and components are the domain of Full-Scale Research Division. Specialists here are particularly concerned with lift,

drag, moments, static and dynamic loads, and aerodynamics of propulsion.

Stack's Theoretical Mechanics Division actually is split into two branches—astromechanics and mathematical physics. The first studies problems in navigation, guidance and control of both manned and unmanned spacecraft for lunar and planetary missions. The second is a small band of highly specialized scientists working on very fundamental problems in aerospace technology—such as the nature and influence of solar radiation fields, re-entry dynamics, and the nature of the lunar environment.

The second functional R&D group is directed by Eugene C. Draley and is concerned primarily with structures and materials research.

His Applied Materials and Physics Division covers a variety of studies of material problems in space. These include *Apollo*-type re-entry, free flight research, study of ionized flow fields (problems associated directly with radio-propagation attenuation and radar identification and tracking), meteoroid hazards, and large erectable space stations.

The Dynamic Loads Division is developing analytical and experimental methods for predicting and alleviating dynamic loads and aeroelastic instability phenomena on high- or specialized-performance flight vehicles. Scientists here also are investigating acoustics, landing and impact, vehicle dynamics, vibration and flutter.

Draley's third division is responsible for Structures Research. Its staff devotes its attention to weight and reliability characteristics of structures and materials in space vehicles and aircraft.

The last of the three R&D groups is under the direction of Hartley A. Soulé.

Guidance, stability, control, operating problems, and recovery techniques and systems in air and space are investigated by the Aero-Space Mechanics Division. Considerable emphasis is placed by the scientists on effective integration of man/machine systems. All types of booster and spacecraft recovery systems also are now under study.

A second division in the group is concerned with Analysis and Computation for the Center. Employing IBM 7070 and 7090 high-speed digital computers and plotters, the unit performs all

**Comparison of Expenditures by Langley Research Center for Fiscal Years 1961-62.**

|                                  | '61            | '62          | Change         |
|----------------------------------|----------------|--------------|----------------|
|                                  | (millions)     |              |                |
| Operating Costs (Salaries, etc.) | \$30.4         | \$33         | +\$ 2.6        |
| R&D contracts                    | 46.8           | 60           | + 13.2         |
| Facility construction contracts  | 24.8           | 20           | — 4.8          |
| <b>TOTAL</b>                     | <b>\$102.0</b> | <b>\$113</b> | <b>+\$11.0</b> |



necessary advanced mathematical computations and simulations for the other R&D divisions. It also handles tape storage and data retrieval.

The Instrument Research Division completes Soule's group. It has responsibility for development and construction of electrical, mechanical, optical, and electronic instruments vital to aerospace research.

• **Contracting procedures**— Obviously, contracting and purchasing procedures are defined by Federal law. Within the framework of these provisions and regulations, Langley procurement is handled as follows:

Key procurement and contract negotiation officers include:

—Sherwood L. Butler, Procurement Officer.

—John Munick, Assistant Procurement Officer.

—Willis A. Simmons, Chief-Contract Negotiation and Administration Branch.

—William B. Hutchesan, Chief-Purchase Branch.

Formal advertising for competitive bids is employed particularly for purchase of supplies, materials, equipment, and construction when these items can be clearly defined by specifications and/or drawings.

When this is impractical—in R&D contracts, for example—procurement is made by negotiation with firms on a qualified bidders list in the desired purchase category.

Technical direction, including project officer supervision, is provided by Langley for all prime contracts under its cognizance. It also employs its own contract-negotiation and administrative staff.

Prime contracts are negotiated directly with the contractor. Langley does, however, retain a flexible procedure in contract administration; it uses either its own staff or the services of the Department of Defense or other government agencies when this is deemed necessary.

Simmons' group handles contracts for R&D procurement by negotiation; Hutchesan's group handles advertised contracts.

In the past, Langley has not made use of the "Quick-Reaction"-type of contracting procedure (QRC) used so effectively by the military. During the past year, however, the Center qualified its first contractors. Others, Langley officials say, will be qualified for different technologies or services.

The first contractor qualified was in the field of optics—the J. W. Fecker Division of American Optical Co. The arrangement with Fecker is in effect an open-end R&D contract—contracts valued at \$100,000 or less will be issued on a simple purchase order.

(Continued on page 136)

missiles and rockets, November 27, 1961

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Modularized console  
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Combining **totally-enclosed** antenna pedestals and advanced servo-controllers, ANTLAB produces tracking systems with built-in reliability. These systems are rugged and versatile and require minimum maintenance. The unique designs incorporate many safeguards to eliminate or greatly reduce downtime, wasted professional time, and other results of costly failures during operational procedures or tracking tests.

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**ANTLAB Antenna Range Instrumentation includes:** Servo and electro-manually controlled antenna test mounts, tracking systems, model support towers, microwave receivers, pattern recorders, pattern integrators, boresight systems, antenna position indicators, fork-controlled oscillators, anechoic chambers, radome mounts, source positioners, etc. Send for catalog A-161.

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**Excellent solderability, even after prolonged storage.**

**Fuses perfectly with gold silicon eutectic alloy without discoloration.**

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(Continued from page 135)

Two other contracts will soon go into effect: one for analog-simulation services and the other for architecture and engineering services (for facilities on the station).

• **Information exchange**—The interchange of ideas and scientific and engineering advances in any organization is of major importance. In the vast nationwide complex of NASA installations, the problem is inherently difficult.

At Langley, all the standard methods of data exchange are employed. These include:

—Broad dissemination within and without of all formal NASA-originated technical reports and of all other pertinent formal reports issued by other Federal agencies, educational institutions, etc.

—Contributions to and attendance at appropriate technical conferences and symposia by as many Langley personnel as practicable within budget limitations.

—Similarly, visits by as many key personnel as possible to other NASA centers and industrial complexes. At the same time, the center encourages visits by others to Langley, to promote the exchange of ideas and advance technologies.

Because of the complexity of the task, information flow for the *Apollo* program will be handled through implementation of the *Apollo* Technical Liaison Plan, of which Langley is a part. Essentially the Plan involves systematic liaison between all associated NASA centers and outside organizations involved in the program.

Liaison groups in which Langley has primary interest have been formed for technical areas—including trajectory analysis, configuration and aerodynamics, guidance and control, heating, structures and materials, instrumentation and communications, human factors, mechanical systems, and onboard propulsion.

Langley officials expect to reap many advantages from the Plan. They have five main objectives:

1. To keep an up-to-date summary of all technical activities pertinent to each Center.
2. To summarize and disseminate all R&D projects and results as soon as possible.
3. To have a vehicle for the reporting of contractor activities to all group members.
4. To create a mechanism for solution of major technical problems as they arise.
5. To unearth problems and needed research areas before they become bottlenecks in the program.

• **Expenditures up**—Fiscal '62 expenditures by Langley are expected to

reach \$113 million. This total includes salaries and expenses for the operation and maintenance of the entire Center, R&D contracts, and facility construction contracts. It also covers the cost of managing some activities of other NASA centers and government agencies. (For example, Langley manages the establishment of the Project *Mercury* ground instrumentation and tracking network for Goddard Space Flight Center.)

The \$113 million outlay is \$11 million, or about 10%, higher than expenditures in FY '61.

The accompanying table provides comparison of spending in the two years. While salaries and expenses show modest increase, costs for R&D have climbed over 25% in one year. New facility costs have dropped nearly \$1 million, as construction slowly catches up with building requirements.

Personnel needs at the Center are expected to bring in an additional 400 persons, for a total of 3628, by next July. The new employment will be principally for administrative support rather than for scientific or engineering activities.

• **R&D contracts**—A close look at the funds to be expended during FY '62 for R&D reveals that the most of the \$60 million will be allotted for hardware and materials.

Langley officials told M/R that half the total funds available will be used to purchase *Scout* launch vehicles. About \$25 million will go for supplies, materials, and equipment needed to support in-house R&D programs. The remaining \$5 million will support industrial contracts for basic research.

• **Looking ahead**—The future of NASA's senior laboratory undoubtedly will match its long past, during which it has continuously been in the center of aviation/missile/space history.

Langley can trace its involvement in the missile field from its early experimentation in 1918 with the Navy Aerial Torpedo—a modified Curtiss Wright aircraft used as a drone carrying a 1000-lb. explosive package—down to its current research on para-gliders *Dyna-Soar*, *Apollo*, and the Mach-air transport.

NASA Administrator James E. Webb stated recently that current expansion of the Center is only the beginning. During this fiscal year alone, over \$2 million is authorized for expanding and modifying old facilities and building new ones.

A vital part of NASA's vast but still growing in-house scientific capability, major center of materials and structure research, Langley will continue to advance the U.S. missile/space effort.



# Lewis May Drop In-House Tradition

SOME MAJOR changes may be in the wind for NASA's oldline propulsion research facility—the Lewis Research Center.

Current indications include:

- A better than 20% increase in technical personnel.

- Shifting of all NASA space electrical propulsion to Lewis.

- Appointment of Dr. A. Silverstein, former chief of NASA Space Flight Programs Office, to be director of the huge Center.

- Addition of a new arm in the Procurement Section at Lewis, an assistant for Development Procurement, and an increase of between 30 and 40 people throughout the entire section.

While no official statements have been made, it is entirely possible that a fairly large development effort will be handled by the center, beginning sometime during the next 18 months.

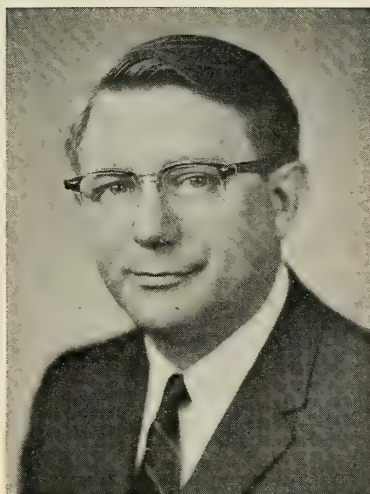
This means Lewis might break sharply with its past tradition of emphasizing in-house research, a tradition which has been maintained even though industry-contracted projects have been slowly increasing.

An increase in development activity, specially in certain segments of the *Apollo* program and electrical propulsion, has led to speculation that Lewis might be in the \$400-million category—including all center activities. But this dollar figure is labeled "fantastic" in some quarters.

- **Current expenditures** — Lewis is currently working with a budget in the neighborhood of \$55 million, about \$25 million of which will be spent in Fiscal 1962. Salaries and other items account for approximately \$30 million. Large construction and major equipment requirements will gobble up 60% of the remaining \$25 million.

Construction is announced almost entirely by formal advertising. Standard government procedure is normally used: 30-day bid time, a formal opening, and an award to the low bidder under a straight-fixed-price contract.

Lewis currently looks for contractors capable of earmarking requirements and giving 5-to-10-day delivery on whole classes of housekeeping items.



DR. ABE SILVERSTEIN

*Major development assignment in works?*

So far, not many research and development jobs are available. But contracts for R&D of propulsion systems, materials, cryogenics and gases are increasing in number. They are usually negotiated and cost-type.

Lewis' key purchasing men are J. R. Biggs, Procurement and Supply Officer; J. H. Zimmerman, chief, Purchase and Contracts Branch; and N. C. Prahst, Small Business and Contracts Relations.

Small business possibilities are good. Last year 70% of all business and 40% of all contracts over \$2500 landed in this area. Major equipment purchases in the latter category will be heavy in 1962.

- **Procurement setup** — The main elements of the Procurement and Supply Division at Lewis follow, together with their personnel and areas of responsibility.

The General Contract Section purchases research and development and other major items. L. P. Kelley heads the section and specializes in price and cost analysis, major negotiations, consultant services, research and development, cryogenic and high-vacuum equipment. B. Torre handles mechanical, hydraulic, and pneumatic pumps,

major electrical and electronic systems.

W. Park covers instrument repair, laboratory equipment and some special projects procurement while L. Goulden covers special projects procurement.

The Construction and Contract Services Section is run by R. W. Bouman, who is also responsible for building and facility construction and architect-engineer services. S. Maun and W. Colli handle repairs, maintenance, new construction and alterations.

The Small Purchase Section buys minor equipment items, stock, operating supplies, fuels and fuel-handling equipment. Section head is G. J. Widra, who also specializes in gas-transport equipment, cryogenics and gaseous propellants.

E. L. Kozar buys mechanical equipment and supplies; A. Krismanth handles chemicals, fuels, lubricants, coatings, cutting tools and radio-active materials; W. T. Hodges buys base metals and photographic supplies; I. Nelson specializes in hardware, mill and medical supplies and F. R. Riedel handles electric, electronic parts and aircraft fittings.

The Contract Administration Branch, under J. M. Katzman, handles all modifications to current contracts, regardless of commodity.

- **Interlocking divisions**—The Lewis Research Center is NASA's principal propulsion facility. It covers 350 acres adjacent to the Cleveland Hopkins airport, with additional research reactor and rocket installations at the 6000-acre Plum Brook section, Sandusky, Ohio. Total personnel is around 3000, with an additional 600-plus to be hired in the current NASA recruiting drive.

The center has eight basic operating divisions with the usual support, financial, and administrative sections. The Plum Brook reactor facility is now under the Nuclear Reactor Division, but it will shortly be established as a separate operating entity.

There will probably be some shifts in the directorate setup at Lewis as a result of the recent appointment of Dr. Silverstein to the top job. But it is not expected that the basic areas of interest within the current divisions will be





including one to Warner and Swasey's Research Labs to develop a method of measuring temperature and composition through infrared techniques.

The Rocket and Aerodynamics Division, under C. F. Schueller, handles all the wind tunnels at Lewis. The tunnels have been involved in *Saturn* base heating studies and efforts are under way to correlate this data with that from other NASA centers and the actual flight information from the Cape. This work was carried out in the 8-by-6-ft. Supersonic Wind Tunnel with small-scale operating models of the *Saturn*, including several modified for *Apollo*. The center also has a 10-by-10 ft. Wind Tunnel.

• **Into fluorine**—Altitude performance characteristics of the *Centaur* engine, including controllability, are being evaluated at this division. Lewis is running one barrel but simulating the second through a loop system to investigate unequal operation.

In the category of general research, studies into the ignition of high-energy propellants are being carried out. The division has been in the high-energy area, including hydrogen-fluorine, for over 5 years. The work is aimed at future large-velocity-increment missions and includes injector designs, performance, control requirements, cooling and all the aspects usually associated with a general rocket program. Pressurized HF systems are used on stands and in altitude chambers originally built for turbo- and ramjet-engine studies.

In this division there is also a mission analysis group whose prime function is to outline research problems to provide general guidelines for research direction at Lewis. The group raises questions in atmospheric braking, powerplant sizes, vehicle layout concepts and other areas. The constant progress across the country means this group is constantly revising old problem areas or generating new ones.

The Nuclear Systems Division, under the direction of D. S. Gabriel, handles the NASA-Lewis efforts in *SNAP-8*, *Rover* and the zero-gravity work on liquid hydrogen storage and cycling.

The nuclear rocket work is highly classified but the systems division handles such problems as:

- Contract responsibility for long-period testing (wind tunnel conversion).
- Experimental heat transfer work, flow stability, start-up cycle.
- Hazards associated with flying reactors and the type of ground facilities needed as the program develops.
- Investigations on follow-up programs beyond *Rover*.

There are several other areas, and the division is also called upon to sup-

ply contract monitors. In addition, some problem areas are passed on to other divisions at Lewis for solution. Generally, the division supports the nuclear rocket with the exception of the reactor.

Power programs in the division include *SNAP-8*, *Sunflower* and about a dozen other contracted efforts in advanced research. A certain amount of support work on *SNAP-8* is carried out at the center. The *Sunflower* project is almost entirely contracted, but the division expects to have a greater in-house program in the near future.

The Fluid Systems Division under I. I. Pinkel has two general areas of interest—propellant system components such as pumps, tanks, valves, etc., and space power components.

Propellant component research digs into the pump design for cryogenic  $F_2$ ,  $H_2$ , and  $O_2$  systems. The group studies novel approaches—such as multi-stage turbines with a single-rotor disc.

The insulation problems connected with cryogenic tanks being stored or used a long time in space are part of the work here. The messy heat transfer problems in this area become quite complex (see NASA Propulsion, p. 62).

Space power components mean involvement in liquid metal systems. This part of the division's research work moves into zero-gravity environments and the headaches associated with phase separation under such conditions.

Pinkel's people worry about the degradation of radiators with respect to time, heat rejection and circulation problems. In addition, the division supplies teams for such current projects as the F-1, J-2 and *Centaur*.

Pinkel says Lewis is no longer self-sufficient in the fluids area. There is a growing need for a "satellite" industry, but division personnel try to stay with those problems that lead to deeper understanding of the field.

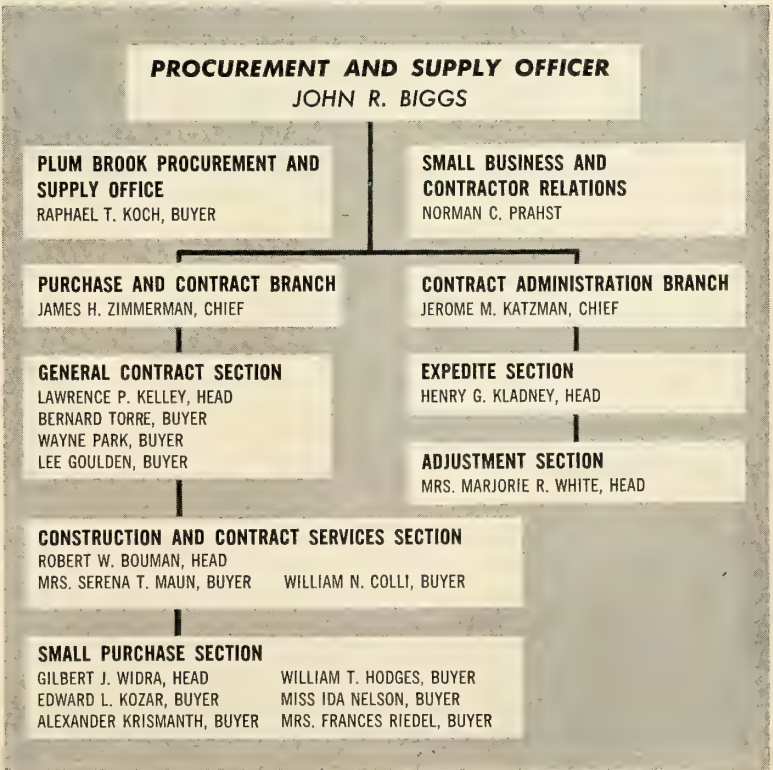
This is not to degrade the industry effort. The division just does not want to learn too much from contractors on a fundamental level.

• **Ion power**—The Electromagnetic Propulsion Division, directed by W. E. Moeckel, is the one section likely to expand because of the shift of all NASA electrical propulsion efforts to Lewis.

The division is currently broken into three branches—electrostatic propulsion, plasma physics and electromagnetic.

The Electrostatic branch is involved in cesium tungsten engines, studies of contact ionization, colloidal particles and the mechanics of propellant feed systems.

The branch is currently building a flight model of the Kaufmann ion engine (named after the Lewis developer) for flight testing with the Hughes engine. The unit operates through the electron bombardment of mercury and





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The Plasma Physics branch studies heating and accelerating plasmas using a traveling wave 40kw power supply and a coaxial transient plasma accelerator. The temperature work is mainly concerned with getting a plasma in a contained magnetic field as hot as possible. If temperatures in the 100,000° to 200,000°F range can be reached, there may be applications in a thermal plasma jet. There is also some thought of applying thermonuclear power to rocket propulsion.

The Electromagnetics branch is concerned with the development of intense magnetic fields, upwards of 100,000 gauss, for plasma containment and power conversion.

A water-cooled magnet is currently running at 100,000 gauss, and investigations of superconductive materials for radiation shielding are in progress.

Two vacuum chambers and a housing facility are under construction. The chambers—25 ft. diameter by 70 ft. in length, and 15 ft. diameter by 60 ft. in length—will be used for engine evaluation in simulated space environments including both solar radiation and temperature controls. Plans for a large liquid helium facility have been made with the cryogenic supply also slated for some superconductivity work on the big magnet.

Current contracts under the auspices of Marshall are being shifted to this Lewis division.

The Materials and Structures Division, S. S. Manson, chief, is primarily concerned with metals and their behavior under the various conditions imposed by space and space vehicle requirements.

Most of the work is research and fundamental in nature, but the division has handled some specific application projects for Lewis, NASA and the military.

General work in fatigue, effect of imperfections and single crystals in the various metals, alloys and inorganic composites is pursued. The division pioneered in defining the needed properties in steel for aircraft and space applications.

The division's extensive facilities are a research effort in themselves. High-temperature physical measurement instruments, a 1000-ton vertical extrusion press, heating and melting facilities including an electron beam furnace and an arc melting unit currently being modified with a large vacuum work-area (see NASA Materials, p. 68).

• **Plasma parameters**—The Instrument and Computing Research Division, under J. H. Hall, handles funda-

mental measuring problems as well as providing computer service groups to the rest of the research effort at Lewis.

Fundamental work includes such studies as how to measure the characteristic parameters of ionized beams in plasma, and temperature measuring techniques beyond the current state of the art. Techniques to determine the nature of residual matter in vacuum chambers and the establishment of standard calibrations in liquid hydrogen flow meters are other examples.

The division has two large computers—an IBM 704 and a modified Univac 1103. The latter is part of a built-in data system with direct connections to test cells.

Hall's group also provides onboard instrumentation for certain experimental space shots. The division does not handle all of the Center's instrument work; there are operational groups within each of the other sections.

The Nuclear Reactor Division, under L. V. Humble, is involved in reactor physics and the improvement of reactor theory in general. This division is currently associated with the Plum Brook reactor, but the latter is slated for separate operational status. This will not dissolve the close ties between the groups.

NRD boasts one of the six cyclotrons in the U.S. It is used to investigate the effects of radiation on matter, the determination of half-life in certain materials, and for other purposes.

Humble's group looks at concepts and farms out some problems to other Lewis divisions. Heat transfer problems in reactor technology are also part of the division's effort.

Advanced ideas—such as applying gaseous reactors to nuclear rocket systems—are being studied. Here a typical problem would be how to keep the hydrogen propellant from mixing with the uranium particles. The vortex approach is under investigation. The main reason is to push the nuclear rocket engine temperature higher and higher.

There is also some small effort in the area of the mechanical properties of solid hydrogen. This fell to the division more or less by default, since the necessary equipment was there. Other minor studies are in the properties of hydrogen at 100,000°F.

The reactor division is primarily research, while Plum Brook is more of an operating group. The reactor itself designed completely by NRD personnel went into operation last April. The unit is being used as a tool for the study of components and materials under radiation conditions very similar to those anticipated in full-scale, nuclear-powered spacecraft systems.



# Life Support Effort Upped At Ames

**Simulators for advanced spacecraft and major expansion in life sciences spark new growth at West Coast center; most procurement supports in-house programs**

NASA'S Ames Research Center at Moffett Field, Calif., is moving heavily into studies applicable to support of manned space flight. This represents a major shift from its long-term function in advanced aerodynamics.

The center's share of NASA's FY '62 outlay has been upped to \$30 million, with long-range forecasts of an additional 25% increase within the next 3 to 10 years.

The major programs to be carried on at Ames include:

- Development of multi-purpose advanced space vehicle motion simulators applicable to *Apollo*-type spacecraft and supersonic transport studies.

- Development of life-support systems for extended simulator runs.

- Vibration simulators to aid in the study of *Saturn* launch vibratory characteristics.

- Life sciences, slated for a major expansion with probable breakdown into microbiology, environmental biology, biotechnology, and physiological and behavioral sciences.

- Guidance, control, and re-entry studies with applications to *Apollo*, *Dyna-Soar*, and other manned spacecraft.

Exactly what this build-up in the simulator and life science areas will mean in terms of actual physical equipment and expansion is difficult to predict with any accuracy at this point. Ames has a considerable in-house capability for fabricating its own devices, usually at heavy savings.

For example, the center's recently completed centrifuge and cab device has put together using much existing hardware for \$385,000. Center engineers estimate the cost would have been \$4 million had external production been necessary. Special analog devices and



SMITH J. DeFRANCE  
*Primates and personnel—a problem*

electrical power requirements also lend themselves to in-house development by Ames since few, if any, of these items are commercially available.

- **Low procurement**—Ames is among NASA's smallest installations in the amount of money spent with industry. Most of its outside buying is in purchase orders, not contract awards, since it is not a production facility.

Ames was involved in only 2% of the total NASA procurement (items over \$25,000) in FY '61. This does not include utility contracts—electric power alone costs the center some \$2 million per year. Excluding utilities, Ames spent about \$11 million last year and will probably exceed this for FY '62. One of the center's major outside contracts at present is a Mach-50 test facility. Total for this high-speed, high-

temperature unit may be \$5 million.

Electronics and electrical devices comprise the largest share of all Ames procurement (no percentage figure is available). Most of these purchases involve components rather than complete assemblies or systems.

Approximately 22% of the center's procurement dollar volume goes to small business. This also translates as 71% of the center's procurement actions.

Some procurement and contract awards are difficult to categorize—the center both buys and leases its computing equipment. Also, construction costs, which have been between \$7 and \$15 million per year, are not always reflected in the center's budget because the appropriated funds may not be awarded within a specific fiscal period.

- **Costs up**—Operating costs at Ames have jumped in the past two years by about \$1 million and are running currently between \$4 and \$5 million annually. For example, about 12 million cubic feet of helium are used per year and the price is rising.

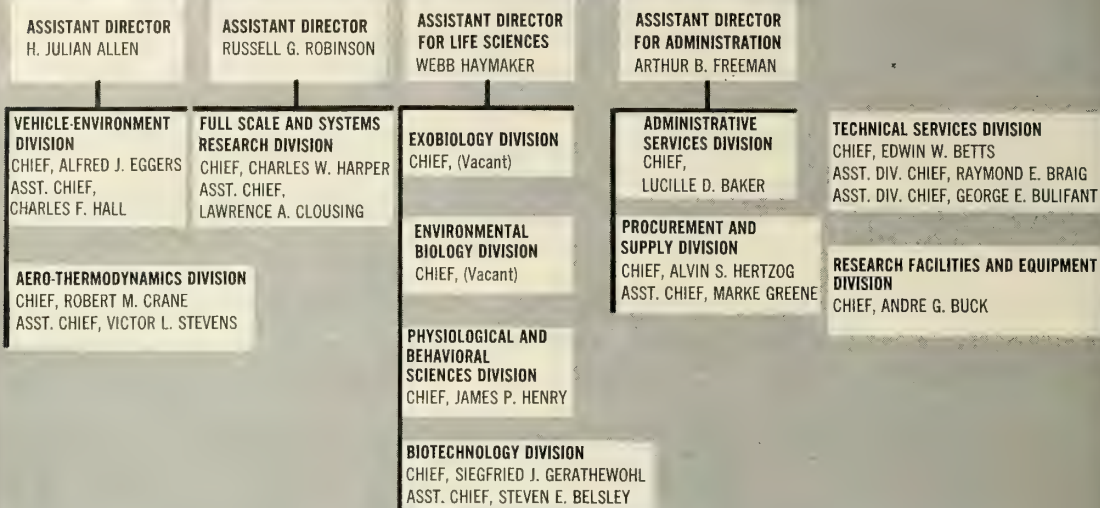
There is also a trend at Ames towards the use of consultants on certain projects, such as the construction and fitting-out of the center's new radioisotope laboratory.

Another factor affecting both procurement and facilities at the center is the buildup of personnel—particularly in professional fields. NASA plans call for 162 new persons to augment the staff at Ames by June 30, 1962. This will bring the total to 1675.

Plans to develop primate training facilities at Ames illustrates the personnel problem—if it is a problem. There are two accepted and proven systems for primate training that may be purchased with relative ease.

The system which Ames intends to

**DIRECTOR**  
SMITH J. DeFRANCE



use, however, is a combination of two selected at the suggestion of scientists involved with the project-to-be. They believe that the combination system will do a better job than either of the other two, but it poses some problems with contractors in trying to purchase portions of complete systems.

In the space simulator area, it is difficult to pin down Ames' efforts on programs such as *Apollo*. However, a group has been formed which will work directly in simulation for various *Apollo* phases after the program has been better defined.

Some type of environmental adaptation to the present simulators will probably be needed, and may go out to industry in contracts. A life support system for extended simulator runs will be high on the list. This can be purchased on a reasonable off-the-shelf basis. Ames scientists feel there is at least one and probably more such systems that would meet their requirements.

In other areas, such as air conditioning for the simulators which would duplicate space conditions, the center believes it may be able to purchase systems. Some of these are not yet on the market, but Ames is aware of some systems built by various firms hoping for *Apollo* usage.

Vibration simulators are another area of interest, but Ames says it will have to have far more data on *Saturn* launch vibration characteristics before it will decide exactly what it needs.

• **No duplication**—The life sciences group is beginning a slow expansion. It has been authorized 100 persons this fiscal year, but the type of personnel this group seeks is not easy to find. The 100-person figure does not include support personnel.

Now in the process of forming into organized groups, the division will probably break down into four major areas mentioned earlier. The bio-technology group will apply its efforts in direct support of human factors for manned space programs.

The center says that the life sciences group will not duplicate work being done by the Air Force or other groups—much of the work they plan has not been an AF function to date. Most current work in areas under consideration by the life sciences group is being conducted by universities. About 50% of the university effort has been on the West Coast. Ames plans to keep some of the work in universities on a contract basis if the universities demonstrate competence.

• **G&C work**—Other major efforts which tie directly to *Apollo*, *Dyna-Soar*, and other manned space vehicles involve guidance and control studies, and re-entry techniques.

Ames has about 35 scientists and engineers working directly on support of *Apollo* guidance (both mid-course and terminal) and control systems. This group has been working together for about two months, but some portions of their work (abort guidance and mid-

course technique) have been underway for about five months. The center's effort in guidance and control for *Apollo* is basically a backup of MIT programs plus analysis and evaluation.

*Apollo* guidance is between 50% and 60% of the center's total guidance work. The program will probably double the amount of professional personnel within the next year to 18 months.

Other guidance and control work at Ames includes satellite stabilization systems and human factors.

Re-entry study is another active area at the center—an estimated 20% of the center staff is directly engaged in re-entry studies (the blunt nose cone concept was developed at Ames with first proof successes in June, 1952).

Most of its *Apollo* work grew out of the satellite re-entry studies. Industry has worked very closely with Ames in the development of *Apollo* configurations. Only two companies involved in initial *Apollo* competition have not used Ames-developed data.

One of the most important groups at Ames supplying a big boost in versatility is the instrumentation division. Comprised of about 250 people, the unit has between 75 and 80 professionals in such areas as electrical and electronic engineering, mechanical engineering, physicists, chemists, mathematicians, physical chemists and astronomer. Some devices developed by the instrumentation division have been picked up by industry and are now available on a commercial basis.



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# Spacecraft Recovery Role for Edwards



PAUL F. BIKLE

For FRC, a period of major growth

**X-15 remains primary project at Flight Research Center but officials expect FY '63 budget to double if step-up occurs in perfecting landing system for Apollo vehicle**

NASA'S FLIGHT Research Center at Edwards AFB, Calif., is one to watch in the area of space operations support. Right now FRC officials are predicting their FY '63 budget will hit \$13.6 million—double the \$6,588,000 being spent in the current fiscal year—and spending may go as high as \$20 million in 1970.

This forecast appears partly dependent upon just how major a role the center is given in the development of booster and space vehicle recovery systems in support of *Apollo* and *Dyna-Soar*.

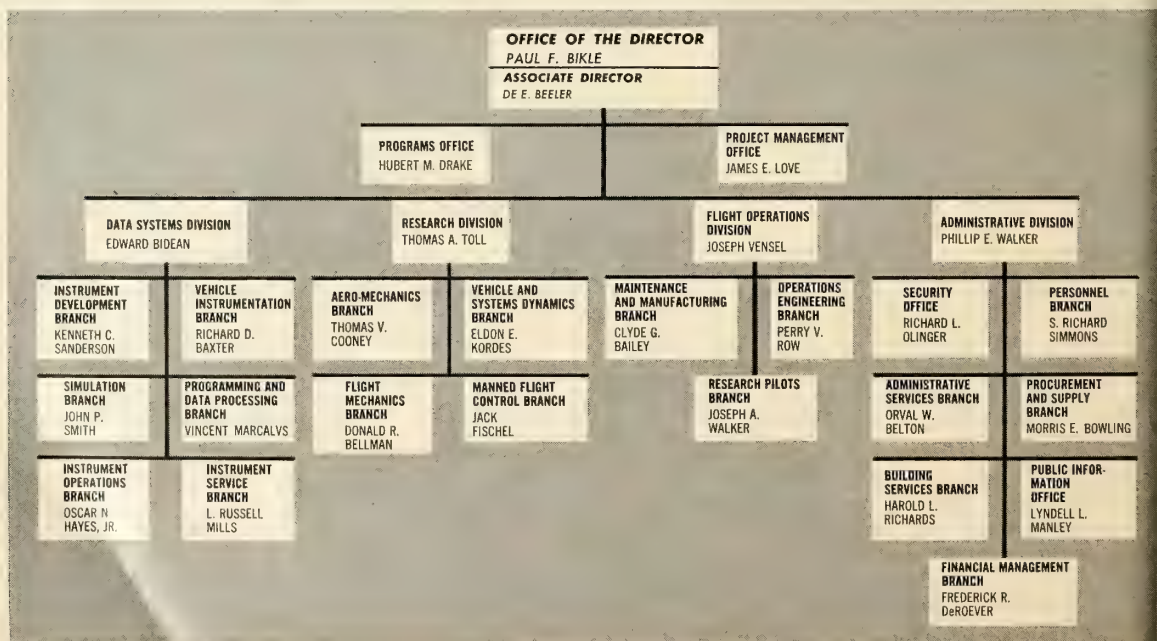
FRC is assuming that both *Apollo*

and *Dyna-Soar* will be recovered in the vast desert areas surrounding Edwards. But no decision has been firmed up yet, either by NASA or the Air Force.

In any event, FRC is embarking shortly on an extensive program in the evaluation of the Rogallo wing, which may be used in the recovery of big boosters and possibly spacecraft.

• **In-house oriented** — Like Ames Research Center, the Edwards facility is mainly oriented in-house. It is rather small compared to other centers, having 419 employees. This figure will go up in FY '62 to an authorized 494.

Over the next 18 years, FRC offi-





cials hope to broaden the center's abilities. They see their efforts moving in the following directions:

|                              | % of Effort |      |      |
|------------------------------|-------------|------|------|
| Fields                       | 1962        | 1965 | 1970 |
| Propulsion—Environment       | 5           | 7    | 7    |
| Fluid Mechanics              | 10          | 9    | 2    |
| Operating Problems           | 5           | 5    | 5    |
| Recovery Systems             | —           | 12   | 19   |
| Materials, Loads, Structures | 20          | 14   | 14   |
| Aerodynamics                 | 25          | 20   | 15   |
| Orbital Rendezvous           | —           | 8    | 8    |
| Control and Guidance         | 35          | 25   | 30   |

The primary program at FRC is still the X-15. The program is now at peak level and will probably stay that way for another year in support of additional research programs.

FRC officials say there is a "very wide field" open with the X-15 aircraft in experiments involving high-temperature, high-mach number flight regimes. There are a tremendous amount of X-15 inputs and proposals from many sources. When they are all milked down, the X-15 becomes the only vehicle available for them. But as presently scheduled, the X-15 will be phased out in about 18 months.

"We have only scratched the surface of X-15 possibilities and intend to maintain about the same amount of work with the aircraft well into 1963," a FRC official says.

• **Dyna-Soar switch** — The center already has a major effort going on *Dyna-Soar*. Three NASA pilots are assigned to Boeing for the project, and at least one of the three is at Boeing at all times.

For *Dyna-Soar*, FRC will step out of the familiar operational phase it has held in programs such as the X-15 and move into technical support.

FRC is also developing some *Dyna-Soar* hardware specifications to assure that maximum benefit will be obtained from the test program. The center's approach to this area is much the same as it was for development of X-15 technical data. When this phase of *Dyna-Soar* is completed by FRC, it will spend a good deal of time planning for overall *Dyna-Soar* operations.

In another area of *Dyna-Soar*, FRC will play a large part in developing instrumentation specifications to get needed data and research information. It will also have the responsibility for reduction and publication of *Dyna-Soar* data. But, FRC project directors point out, the center will only be involved in technical aspects—the Air Force will handle all *Dyna-Soar* operational areas.

If *Dyna-Soar* and *Apollo* are recovered at Edwards AFB, a buildup of FRC's recovery and tracking capabilities would be needed. But the center

says this would not be a major project as far as installation of a large amount of additional equipment is concerned. Much of what would be needed for both projects is already at hand and in use for the X-15 program. Some equipment modifications would be in order, but FRC already has the capability to guide a manned vehicle recovery.

FRC is developing some instrumentation requirements for *Apollo* recovery and has been working on lunar landing studies.

The center is studying rendezvous techniques using a manned system, and has built a small development model of such a system. Still other work includes some studies of non-winged lifting bodies.

• **Aircraft work**—A very large portion of FRC work will be on the supersonic transport. The center is slated to receive its first B-58 next spring for operational and SST handling studies.

There is a considerable amount of cross-over between the work at FRC and at Ames. Some of the same areas are being studied but from different points of view. Ames is concerned with

large amounts of research. FRC is concerned more with development aspects.

FRC facilities include the basic 170-acre "corner" at Edwards AFB. It has a large laboratory area, two hangars, supporting shops and shop equipment.

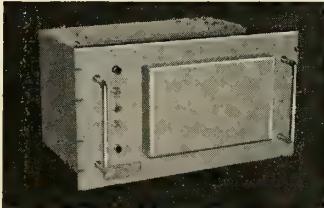
There are four fixed-base simulators, but no motion simulators at the present time. In the future, a general purpose flight simulator, a high-temperature loads calibration facility and other additional buildings are planned.

The center looks upon its aircraft as simulators. Going back upstream in the X-15 program, FRC's variable stability F-100 and reaction control-equipped F-104 have both made major contributions to the X-15 as well as other programs. The X-15 itself can well be considered a simulator for still more advanced hardware and flight techniques.

Most of FRC's budget goes for its own operations. Its procurement runs mostly to relatively small purchases. It prefers to operate similar to Ames—buy the parts it needs, but put together its own systems to meet its own specific requirements. **\*\***

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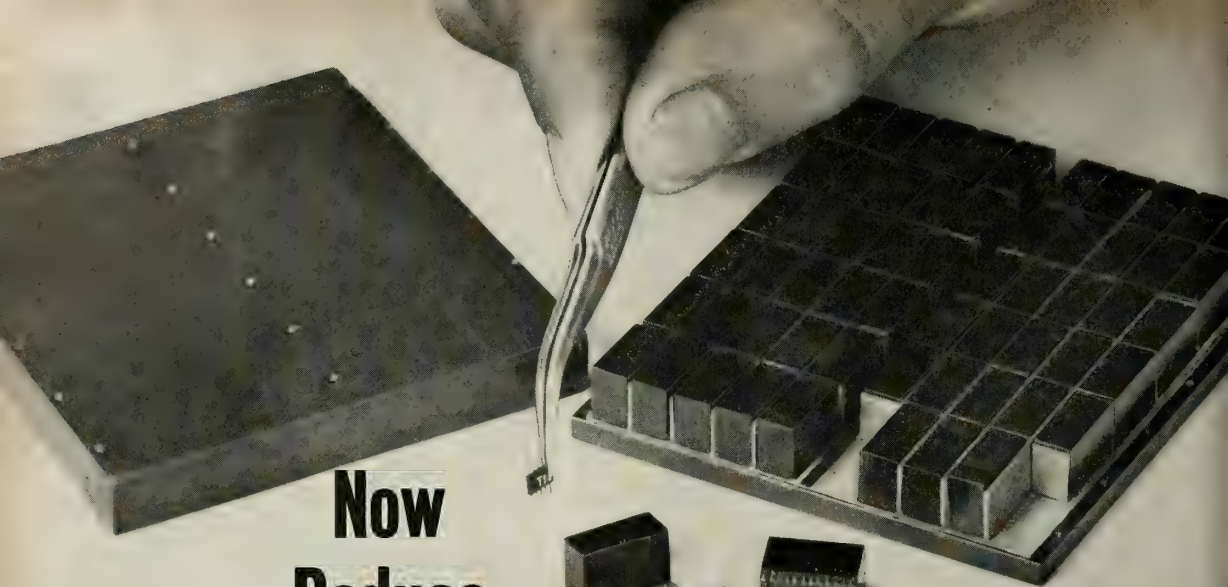
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Power Supply \_\_\_\_\_ 3 to 6 volts  
Temperature Range \_\_\_\_\_ -55° to +125°C

| UNIT     | TI SN 510                                    | TI SN 511                              | TI SN 512               | TI SN 513                                            | TI SN 514                          | TI SN 515    |
|----------|----------------------------------------------|----------------------------------------|-------------------------|------------------------------------------------------|------------------------------------|--------------|
| FUNCTION | Flip Flop, Counter                           | Flip Flop with emitter follower output | NOR/NAND Gate (6 input) | NOR/NAND Gate (6 input) with emitter follower output | Two NOR/NAND Gates (3 inputs each) | Exclusive OR |
|          | Clock pulse is internally capacitive-coupled |                                        |                         |                                                      |                                    |              |

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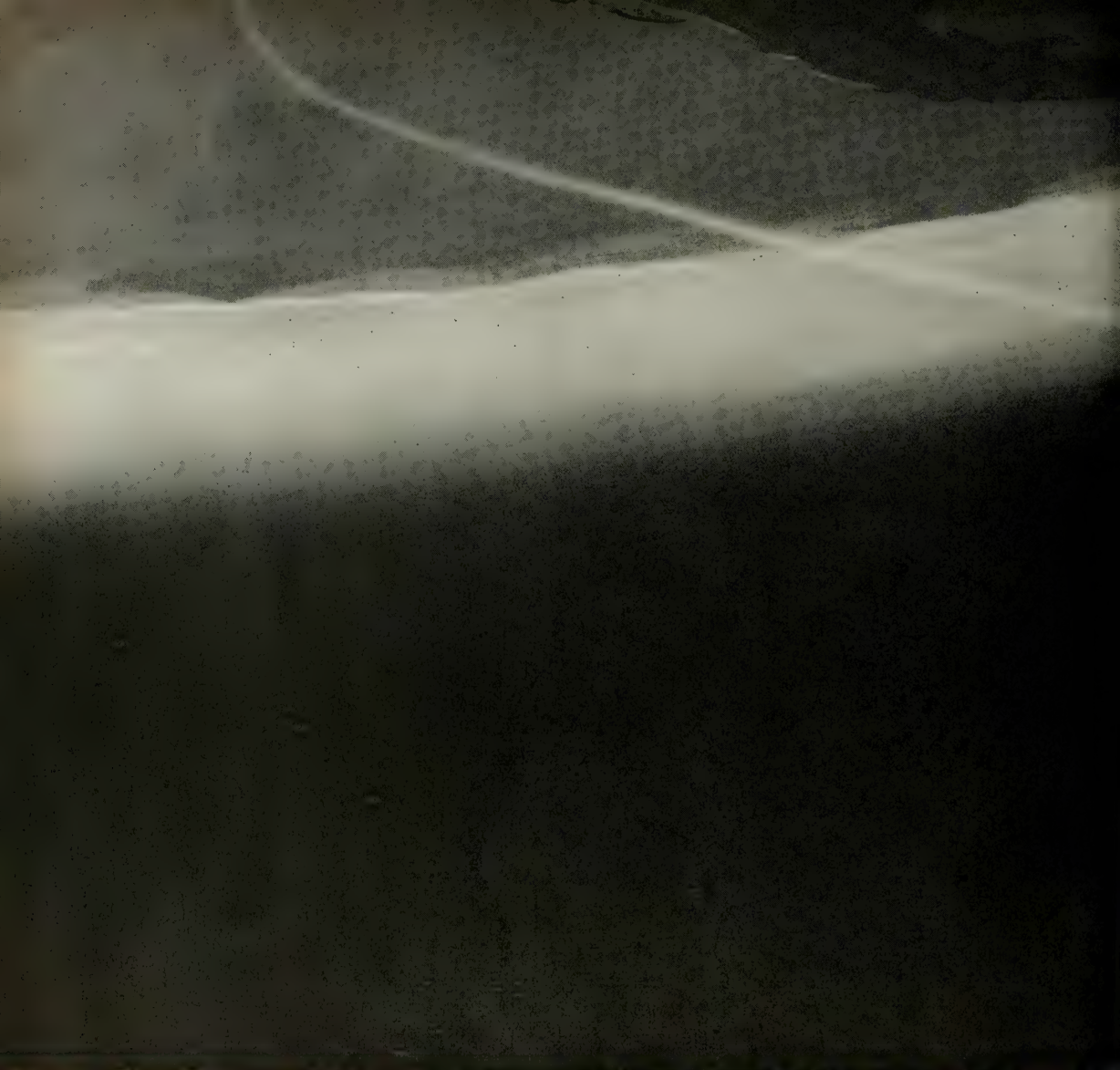




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A new series of high-density propellant compounds, called Nitro-C rubber, provide 6% more energy per pound than present rubber-based fuels. This increased output permits reduction in weight and physical size of small rocket motors. The propellant retains its physical properties over an extreme temperature range . . . from  $-110^{\circ}\text{F}$  to  $+250^{\circ}\text{F}$  . . . and is vastly superior to other high-energy composites at both temperature extremes. This makes the propellant dependable for tactical military missiles, as well as for high-mass-ratio motors for space probe and satellite applications. The B.F. Goodrich Rialto Plant, which developed the Nitro-C compounds, is equipped to handle complete small rocket motor projects . . . from research through design, testing and production. For complete information write *B.F. Goodrich Aerospace and Defense Products, a division of The B.F. Goodrich Company, Akron, Ohio.*

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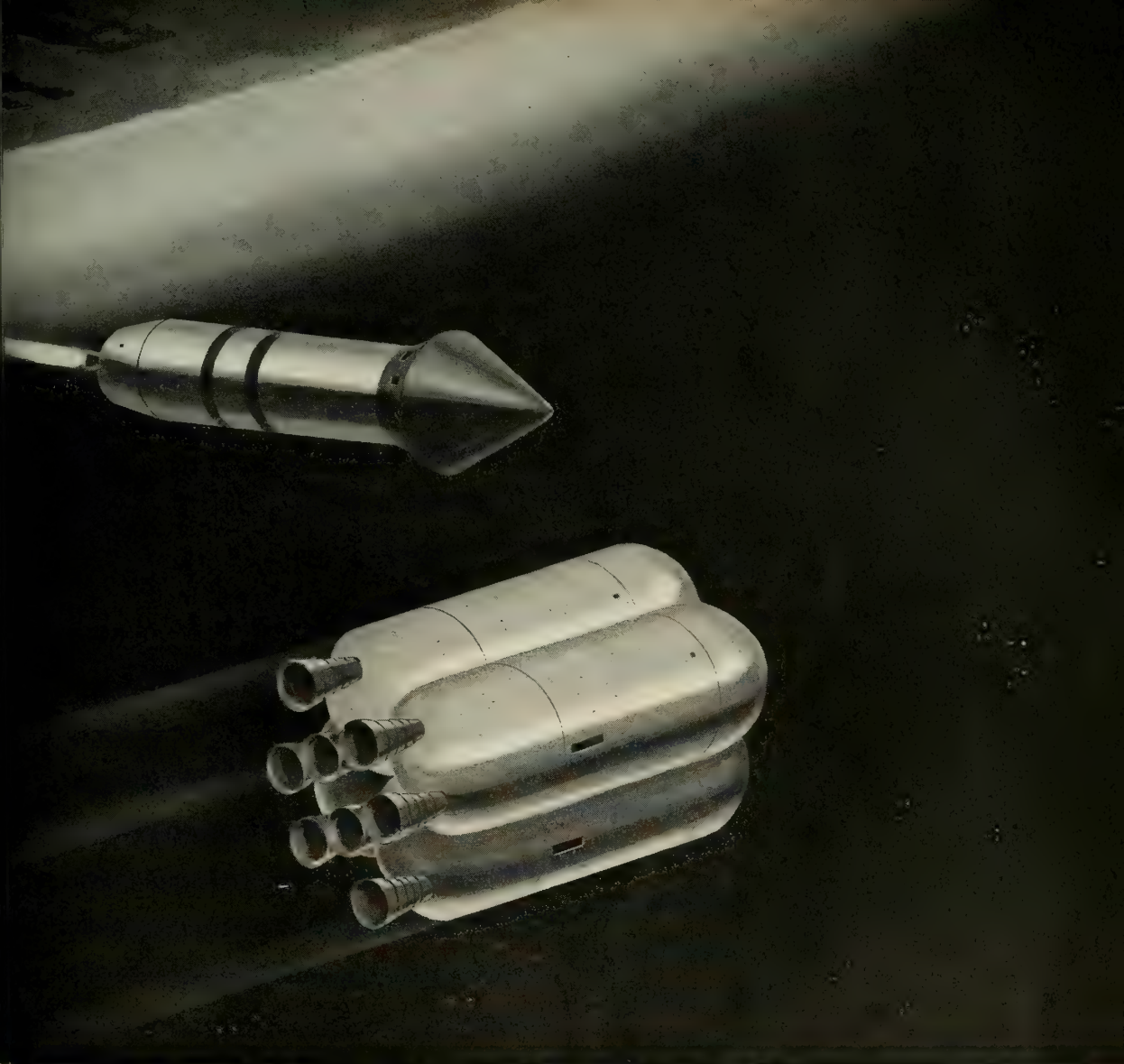


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## ***sensor capability to space rendezvous***

The experience gained from the inertial guidance system for the advanced Polaris, coupled with the proven success of the Hawk and Sparrow C W homing systems give Raytheon the most extensive proven capability applicable to the space rendezvous guidance problem.

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# Technical Countdown

## ASTRONAUTICS

### Micrometeoroid Studies Pushed

Particle velocities of 20,000 ft./sec. are being achieved by Technical Operation Inc., of Burlington, Mass., in its studies of micrometeoroid collisions with space vehicles. Using a "gun" based on the exploding bridgewire principle, micro-size particles are accelerated and impacted against samples of various metal now in use in spacecraft hull construction. Work is sponsored by Aeronautical Systems Div. of AFSC. Test results will aid in determining "probable effects". However, past space flight research has indicated that micrometeoroids in infinite numbers traveling in showers may attain velocities up to 250,000 ft./sec.

### Advanced Control System Developed

Rotatable auxiliary rockets are used in a new missile/space vehicle control system developed by Allison Division of General Motors. Designed for altitude and velocity control, it provides highest payload yet of any thrust-vector system, developers say. Described as highly efficient and compact, the control system can operate fore and aft of main propulsion motors to assist in staying, velocity trim, and coast.

## PROPULSION

### X-15 Headed for New Heights

Having carted away all the speed records in sight, NASA's X-15 experimental rocket plane is literally looking around for new horizons to conquer. Around the middle of next year, according to one Edwards AFB source, the X-15 will be flown at much higher altitudes—around the 400,000 ft. mark. The plane now holds the unofficial altitude record of 217,000 ft. for manned, powered flight. Main point of controversy in the high-altitude flight program is whether the existing powerplant can do the job. As yet, this question has not been resolved.

## SUPPORT EQUIPMENT

### New Facilities for Goddard

Goddard is planning to install a series of "exotic" facilities to check out satellite payloads. In the works are a magnetic test facility able to produce rotating and controllable and magnetic fields, a moment-of-inertia facility for testing spacecraft control systems, and—still a few years off—a 100 ft. centrifuge for work with *OGO* and *POGO* satellites. These facilities are in addition to two environmental chambers the Center has under construction.

### Thiokol Diversifies Into Ground Vehicles

A lightweight, low-cost tracked vehicle produced by Thiokol's Logan works is under review by the Army. The nit, capable of climbing 45°-plus slopes and traveling over mud, snow, sand and rocks, has already been accepted by the Air Force. Commercial applications are also under investigation.

## SPACE MEDICINE

### Martian Microorganisms a Menace?

Space-vehicle sterilization is a two-way street. Human survival on earth could depend on avoidance of contamination from returning vehicles, Lockheed Missile & Space Co. scientists assert. The group has proposed a five-year program to study biological decontamination techniques and to build ground and in-flight sterilization units before round-trip space missions are effected.

## ADVANCED MATERIALS

### Cermet Coatings Protect to 2500°F

AMF scientists have protected molybdenum against oxidation for five hours at a temperature of 2500°F with an electrodeposited layer of an Ni-Si cermet 5 mils thick. In parallel tests a Ni-Zr oxide cermet, also 5 mils thick, stood up on molybdenum for 468 hours at 2000°F. These and other systems were prepared by co-depositing the particles with the metal in the baths.

### Tungsten Nozzle Liners in Production

Rocket nozzle liners and jet vanes of high-pressure cast tungsten alloy are in production at Oregon Metallurgical Corp. The material is directly forgeable without prior breakdown, due to the fine grain structure. The casting is made by pouring arc-melted molten metal into rotating graphite molds.

### Three-Story Electron Beam Furnace

Temescal Metallurgical Corp. has turned out a tantalum-tungsten ingot 7 in. across and 6 ft. tall. The ingot was formed in a three-story electron beam furnace capable of more than a million pounds per year of exotic metals. The ingot size will make possible economical production of larger missile parts. The 90Ta-10W alloy can take temperatures ranging from -420° to 6500°F.

### Non-polymeric Polymers Through Radiation

The National Bureau of Standards has succeeded in polymerizing such normally non-polymeric monomers as carbon disulfide by initiating the reaction with radiation and favoring it with pressure. While the work has not progressed far enough to warrant detailed conclusions, some general theories have been formulated on the pressure effects and reaction parameters.

### Navy JATO's at McGregor

Rocketdyne will be producing MK-25 JATO's under a BuWeps contract at the firm's McGregor facility in Texas. The units provide 4500 lbs. thrust for five seconds and contain a flameless propellant. The exhaust gases will not produce fogging conditions which might hamper takeoff operations.

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|---------------------------------------------------|-------------------------------------------|----------------------------------------|-----------------------|----------------------------------------------------|---------------------------------|
| <b>SKYDROL® 7000</b>                              | -40 to 200                                | 15.5 @ 100<br>4.00 @ 210               | <-70                  | 200                                                | 1.08                            |
| <b>SKYDROL 500A</b>                               | -65 to 225                                | 2300 @ -65<br>11.5 @ 100<br>3.92 @ 210 | <-85                  | 225                                                | 1.07                            |
| <b>PYDRAUL® 60</b>                                | -25 to 200                                | 10.0 @ 100<br>2.45 @ 210               | -70                   | 200                                                | 1.09                            |
| <b>PYDRAUL 150</b>                                | -15 to 200                                | 30.8 @ 100<br>8.0 @ 210                | -55                   | 200                                                | 1.13                            |
| <b>PYDRAUL F-9</b>                                | +50 to 300                                | 47 @ 100<br>5.5 @ 210                  | 0                     | 300                                                | 1.28                            |
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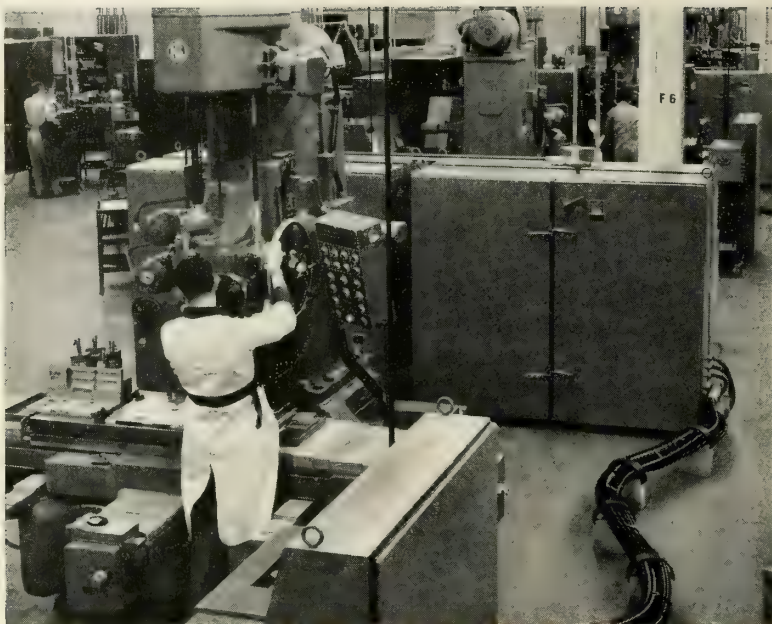
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|----------------------------|-------------------------------|-------------------------------------|-------------------------------------------------------|---------------------------|-------------------|
| 328,000                    | 28.9                          | 0.00042                             | YES                                                   | Commercially<br>Available | YES               |
| 308,000                    | 30.8                          | 0.00045                             | YES                                                   | "                         | YES               |
| 328,000                    | —                             | 0.0004                              | YES                                                   | "                         | YES               |
| 319,000                    | —                             | 0.00042                             | YES                                                   | "                         | YES               |
| 387,000                    | —                             | 0.00041                             | YES                                                   | "                         | YES               |
| 400,000                    | —                             | 0.0004                              | YES                                                   | "                         | YES               |
| 375,000                    | —                             | 0.0004                              | YES                                                   | "                         | YES               |
| —                          | —                             | —                                   | YES                                                   | Development<br>Product    | YES               |

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## Pulse Modulated Rocket

A significant advance in space vehicle control devices may accrue from development of a pulse-modulated bipropellant control rocket at Vickers Inc. The control rocket incorporates a solenoid, bipropellant valves, and thrust chamber in one compact unit, to insure reliability, fast response, efficiency, and low power input. It uses a bipropellant

combination of  $N_2O_4$  and  $N_2H_4$ /UDMH. The control rocket shown was developed for vernier attitude corrections of space vehicles with a pulse modulated thrust level of 1 lb. The unique design results in an overall response time in milliseconds, excellent repeatability of impulse bits, and power input requirements of only a few watts.

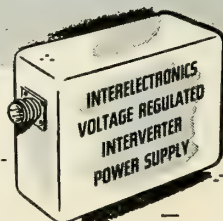
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## Pyrotechnic Initiators

Pyrotechnic initiators with electronic circuitry are in production by Fleming Industries, Inc. Designated Model IN-113, the heavy-duty electronic unit contains a low brisance squib which will not fire with 250 VAC RMS applied continually but will always fire at 500 VAC RMS (700 VDC) or more. The squib has a controlled burning rate for igniting secondary charges without detonation. The initiator is completely shielded and filtered for protection against RF and other radiation.

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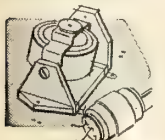
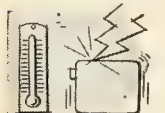
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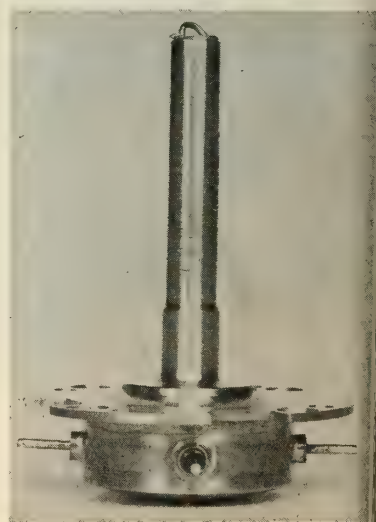


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## Magnetic Measurement

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missiles and rockets, November 27, 1964





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General American's Plate & Welding Division has the space, the skills and the experience you need, whether your problem is one or a dozen special pieces, or a continuous operation involving thousands of units.

General American has produced lox vessels, radiation shields, atomic waste evaporators and missile equipment

components. We are known around the world for the tanks we have fabricated and erected—tanks for storage of petroleum products, acids, chemicals and water; tank cars for transportation of any kind of liquid. We are constantly at work on projects that involve cutting, forming, milling and stress relieving of large metal structures. Our background in aluminum and alloy steels is considerable.

When a job requires custom fabrication of metal—any metal—we generally can handle it faster and better than any one else. We would like to work for you.

Plate & Welding Division

## GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 3, Illinois

Offices in principal cities



Circle No. 95 on Subscriber Service Card

## ... products and processes

instrument is also capable of short-time impulse measurements from 0.1 milli-second up to 1 second. Other specifications include ranges of 500-1000-2000 - 5000 - 10,000 - 20,000 - 50,000-100,000-200,000-500,000 Maxwell turns/division. Internal resistance is 40 ohms, approx., in lowest range. Load resistance (test coil) is 0-60 ohms in lowest range and 30 ohms in other ranges. Absolute accuracy is + 1%, relative accuracy is + 0.2 divisions.

Circle No. 228 on Subscriber Service Card

## Noise-Free Power Supply

A noise-free family of power supplies, featuring precise voltage regulation for both line and load, is available from Raytheon. The six Sorensen QIS 60-cycle models and the six DQIS 400-cycle models are transistorized, miniature 115-volt AC/DC, sine-wave inverters. Operating from 12 or 28-volt DC inputs, the 12 units' outputs, obtained from a Class B amplifier, are 20, 40, or 60 watts. An ideal replacement

for vibrators, the Sorensen supply has eliminated frequency noise and reduced audio noise to a negligible amount. Applications include tape motors, small magnetic amplifiers and gyros, and similar equipment operating indirectly from batteries.

Circle No. 229 on Subscriber Service Card

## Low-Weight Antenna Mount

Weighing less than 1000 lbs., antenna mount Model 28, a servo controlled pedestal for shipboard and ground-based application, is available from Temec, Inc. It is designed for use in telemetry reception and the tracking of aircraft missiles and satellites. Special features include gyro stabilization for shipboard use, a complete solid-state



*the beautiful*

## LANDMARK Co-operative Apartments

**NOW**

**UNDER CONSTRUCTION**

**Completion Date: February 1962**

**RIVERFRONT LOCATION**

**OPPOSITE THE YACHT BASIN**

**First & Only Daytona Beach Co-op Apt.**

**OFFERING YOU:—**

Luxury Colonial design, 12 story Twin Buildings with 2 High Speed Elevators for Each Building . . . Serving only 4 apts. to Each Floor.

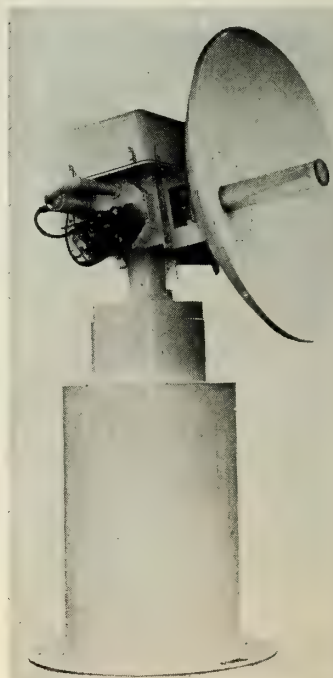
**ALSO, FOR YOUR ENJOYMENT:—**

Beautiful Landscaped Grounds, Swimming Pool, Golf Putting Greens, Lounge for your own entertainment, Under-cover parking for each apt., Central Heat & Air Conditioning.

**EACH APARTMENT SOLD WITH WARRANTY DEED AND  
TITLE INSURANCE COVERAGE**

**FINANCING AVAILABLE**

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404 S. BEACH ST. - CL 5-3684  
DAYTONA BEACH, FLA.



a-c servo system and automatic beam crossover switching from 3db to 9 db. Current production model employs a 5-ft. reflector for use in the 5 kmc. range, but other reflectors and frequencies are available on order. The current system has slew rates of 36°/sec., and accelerations of 130°/sec./sec.

Circle No. 230 on Subscriber Service Card

## 2500 Channel Repeater

Philco Corp. has developed a low-cost coaxial cable communications repeater with bandwidth capability of 2500 voice channels. The tubular 6 in. x 1 in. cable repeater weighs only a few ounces. A cable communications system, employing the 2500-channel ca

missiles and rockets, November 27, 1961



Kan Louisvill, Artn...  
 Ky Louisville, Chester R. L...  
 La New Orleans, C. E. Esposito, 505 E. More...  
 Me Baltimore, C. E. Esposito, 505 E. More...  
 Mich Cambridge, Northeast Electrical Sales, 17-21 West...  
 Mo Detroit, Hoffman Bros., 5291 Martin, MI 6-7994  
 NJ St. Paul, R. J. Bork Co., 872 Curfew Ave., OL 2-6995  
 NY St. Louis, Arbelker Co., 3121 Washington St., WA 5-8805  
 Ohio Linden, Brazill Bros., 11-13 McKinley St., EX 2-5616  
 Pa Long Island City, Becker & Cane, 41-15 23rd St., BR 3-9108  
 Tenn Syracuse, Electrical Agencies Co., 307 W. Division St., BR 2-1363  
 Tex Greenacres, Arthur L. Ehlers & Bro., 826 Goldsboro St., BR 3-9108  
 Va Richmond, Gordon F. Stofor & Bro., 2400 Superior Viaduct, SU 1-3535  
 Wisc Milwaukee, Pyramid Sales Co., 325 N. Franklin St., WA 5-1006  
 ● HATHAWAY INSTRUMENTS, INC., 5800 E. Jewell Ave., Denver, Colo., Tel: SKyline 6-8301, TWX: 68-656 Sls. Mgr: W. A. Christian, Pur. Agt: F. J. Knafelc  
 HAUHAN INSTRUMENTS, INC., 70 Coolidge Hill Rd., Watertown, Dela...  
 HAWKINS COMMERCIAL ELECTRONICS CO., Div. Delaware Broadcasting Co., 920 King St., Wilmington, Del.  
 Hawley Products Co., 333 North 6th St., St. Charles, Ill., Tel: Juna 4-3130; Sls. Mgr: M. McLoughlin, Pur. Agt: H. Breilino  
 Cal Gardena, B-Sure Receptematives, Inc., 1204 N. Woodward, LI 9-6411  
 Mich Royal Oak, Western Molded Fibre Products, 14103 S. Brighton, FA 1-3874  
 Haydon, Div. of General Time Corp., 245 E. Elm St., Torrington, Conn., Tel: Hunter 9-3158;  
 Sls. Mgr: T. M. Sandery, Pur. Agt: E. K. Sallton  
 Cal Los Angeles, 539-661 S. La Brea Ave., HO 2-1452  
 Fla Tampa, Box 1335, RE 6-1480  
 Ill Atlanta, 3223 Cain's Hill Pl., N.W., CE 7-2273  
 Ga Chicago, 6027 Northwest Hwy., NE 1-2722  
 Ill New Orleans, 821 Pontalba St., Audubon 2264  
 La Farmington, 32936 Slocum Dr., GR 6-1141  
 Mich Minneapolis, 738 Northwestern Bank Bldg., FE 6-6218  
 Minn St. Louis, 6653 Enright Ave., VO 3-4454  
 Mo New York, 528 Fifth Ave., MU 7-6130  
 NY Rochester, 74 Park Ave., ED 3-2506  
 NC Charlotte, 625 Harwyn Dr., LO 1-4913  
 Ohio Cincinnati, 902 Federal Reserve Bank Bldg., GA 1-3366  
 Pa Cleveland, 3717 Lee Rd., LO 1-4913  
 Tenn Upper Darby, 46 Garrett Rd., FL 2-5532  
 Tex Memphis, 580 S. Cooper St., BR 5-1914  
 Wisc Milwaukee, 1502 Good Laimier, Riverside 3657  
 FOR: Can, Downsview, Ont., 805 Wilson Ave., ME 5-0121

Ohio Dayton, Autom...  
 Pa Dallas, Aerol Assoc...  
 Wash Seattle, Aerol Assoc...  
 Haydon Switch, Inc., 576 S. Leonard St., WA 5-8805  
 Cal Burbank, TransDynamics, Inc., 165 Sls. Mgr: A. Hilliken, Pur. Agt: R. J. Bork  
 Colo San Diego, TransDynamics, Inc., 165 Sls. Mgr: A. Hilliken, Pur. Agt: R. J. Bork  
 Conn Englewood, Aerol Assoc., 921  
 Fla Bloomfield, Aerol Assoc., 161  
 Ill Winter Park, Aerol Assoc., 410  
 Mich East Point, Aerol Assoc., 410  
 Mo Kenilworth, Aerol Assoc., 410  
 Mass Bladenburg, L.D. Lowery, W  
 Mich Waltham, Aerol Assoc., 1850  
 Mo Detroit, Aerol Assoc., 118  
 NJ St. Louis, Automatic Ge  
 NY Newark, Aerol Assoc., 118  
 Ohio Great Neck, Aerol Assoc., 118  
 Pa Syracuse, W.H. Zimmerman  
 Wash Cleveland, C.A. Robinson C  
 FOR: Dayton, C.A. Robinson C  
 Pa Dallas, Automatic Ge  
 Wash Seattle, TransDynamics  
 Can Toronto, Ont., PI 8621  
 Hayes, C. I., INC., 870 Wellington  
 Ariz El Paso, Pur. Agt: R. J. Bork  
 Cal Phoenix, Southwest I  
 Ill San Jose, C. I. Hayes  
 Mass LaGrange, C. I. Hayes  
 Mich Waukegan, C. I. Hayes  
 Minn Cambridge, E. F. I  
 Mo Detroit, R. H. Schu  
 NJ Royal Oak, Calvin  
 NM Minneapolis, Fou  
 NY St. Louis, Indust  
 Pa Cedar Grove, H  
 Wisc Albuquerque, C.V  
 Ri Tonawanda, W.K  
 Warwick, C.I

## ● HATHAWAY INSTRUMENTS, INC., (See also The Lionel Corporation)

## ● THE LIONEL CORPORATION, (Now includes Hathaway Instruments, Inc.)

• Clemco Aero Products, Inc., Gardena, California • Dale Electronics, Inc., Columbus, Nebraska • Hathaway Instruments Division, Denver, Colorado • Induction Heating Corp., (Ther-Monic®), Brooklyn, New York • Intercontinental Manufacturing Co., Garland, Texas • Lionel Electronic Laboratories, Brooklyn, New York • Lionel-Wadsworth, (Ultra-  
 tion®), New York • M. Steinthal & Co., New York & Roxboro, North Carolina • Sterling Electric Motors, Inc., Los Angeles, California • Telerad Division, Flemington, New Jersey • Lionel Toy and Train Division (and Lionel/Porter), New York, New York / The merging of Lionel and Hathaway generates an unusual capability in the fields of electronics, hydraulics, and nucleonics. From components through subsystems to complete military systems projects, Lionel can be counted upon as a proven source with a new corporate competence.



**THE LIONEL CORPORATION**

Executive Offices: Hoffman Place, Hillside, New Jersey

Circle No. 61 on Subscriber Service Card

## ...products and processes

capacity repeater, initially costs about the same to install as a typical 240-channel microwave system. Multiplexing equipment would be used at either end of the system, as in a microwave system.

Circle No. 231 on Subscriber Service Card

### Drill Speeder

Following the first Drill Speeder Model #62 which increased spindle speeds at a ratio of 7 to 1 with a maximum drilling speed of 22,500 rpm,



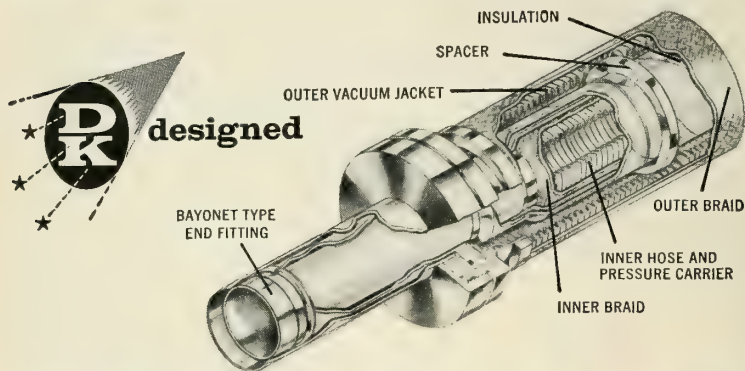
Tapmatic Corp. has added the Drill Speeder Model #125 to their line. This unit has a ratio of 6.25 to 1 and a

capacity from #80-1/8". The Model #125, permits quick and easy installation on all types of drilling machines. The Tapmatic Drill Speeders can be used in manual, semi or completely automated operations on all types of drilling machines.

Circle No. 232 on Subscriber Service Card

### VSWR Power Meter

A feed-thru power meter and VSWR Power Meter, Model VM-2, covering the range of 1 to 30 MC and Model VM-1, covering the range of 10 to 200 MC, is available from Electro Impulse Laboratory, Inc. These RF power meters consist of a voltage divider of



# CRYOGENIC transfer LINES

**DK manufactured vacuum jacketed cryogenic lines have exceptionally low heat exchange!**

Take a close look at the design and construction of the vacuum jacketed transfer line shown here. You'll quickly see why it answers the problem of transferring costly cryogenic materials most adequately!

DK has combined experience, design capability and advanced manufacturing technique into producing a wide selection of vacuum jacketed transfer lines constructed of flexible metal tubing, rigid tubing and vacuum jacketed gimbals in many combinations. These cryogenic lines are finding diverse applications in Airborne as well as G.S.E. service. Available in standard sizes or in special designs to meet special needs.

Our new brochure has complete information including test data. Write, wire or phone for a copy today. Ask about "vacuum jacketed cryogenic transfer lines."

- Cryogenic Storage and Transfer Devices: Containers, Hose, Ducting, Piping
- Pressure Vessels: Titanium, Stainless, Steel, Inconel, Monel, Aluminum, Copper
- Certified LOX Cleaning Facilities
- Certified Testing Facilities
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- Approved Quality Control



**DK MANUFACTURING COMPANY**

5059 South Kedzie Avenue • Chicago 32, Illinois

**DUNBAR KAPPLE DIVISION**

North Island Avenue • Batavia, Illinois

Circle No. 30 on Subscriber Service Card

the feed-thru type and a reflectometer. The frequency range of the voltage divider is d-c to the upper frequency limit of the instrument. A crystal diode across a portion of the voltage divider measures the RF voltage which is indicated on a volt meter calibrated in watts. Because of this feature, the voltage divider can be calibrated at power line frequencies.

Circle No. 233 on Subscriber Service Card

### Angle Drives

The F. W. Stewart Corp. is marketing two angle drives. The 9056HF (T-drive) and 9056-119 (Right Angle Drive) are provided with 1/4 in. diameter shafts out to a 1/8 in. flat to provide a stronger attachment for coupling ends. Primarily used with flexible shafting,



missiles and rockets, November 27, 1961

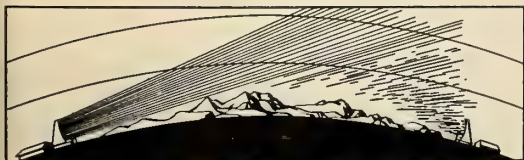




## **ALERT: Litton Communication Systems Advance the Defense Posture of the Free World**

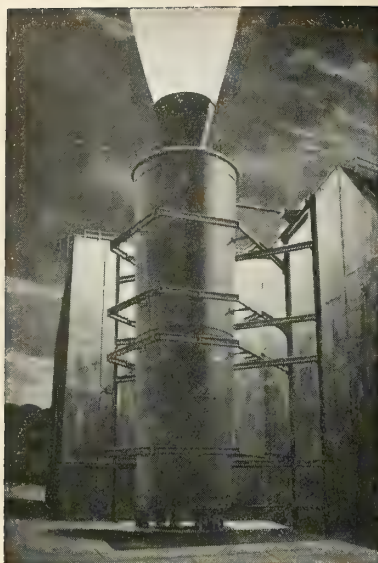
Management of electronic communication systems is a proven capability of Litton Industries, whose European facilities alone include 750,000 square feet under roof and a 3600-man team of engineering, manufacturing and field support specialists.

Professionals qualified to contribute to or direct research, engineering, production or field service in communications and allied fields are invited to investigate the broad spectrum of career opportunities at Litton. An equal opportunity employer.



**LITTON SYSTEMS, INC.**  
BEVERLY HILLS, CALIFORNIA  
A DIVISION OF LITTON INDUSTRIES

TECHNOLOGIES: ADVANCED COMMUNICATION AND DATA RECORDING • COMMAND AND CONTROL • GUIDANCE AND CONTROL • COMPUTERS • BIOELECTRONICS • SPACE SCIENCE • ELECTRONIC COUNTERMEASURES



## Department Head— Aerothermodynamics

This new position is currently available in our Engineering Sciences activity. We are seeking an outstanding scientist who has the stature and maturity to provide technical leadership for a small group of highly qualified aerothermo specialists performing studies concerned with advanced rocket propulsion systems.

The position requires a high degree of creativity. Selected candidates will possess a record of major responsibility and accomplishment in this field, and will be thoroughly knowledgeable in analysis and test work. An advanced degree, preferably a doctorate, in mechanical or aeronautical engineering with a minimum of five years experience is required.

This is a stimulating, challenging position with recognized professional leaders at UTC's modern multi-million-dollar complex, where the very latest techniques, methods, ideas and equipment are available. UTC is located in the San Francisco Bay Area, which features "West Coast living" at its finest.

*If you are interested, we invite you to contact C. F. Gieseler, Dept. 109, United Technology Corporation, Box 358, Sunnyvale, California. All replies treated in strictest confidence.*

All qualified applicants considered without regard to race, creed, color or national origin.



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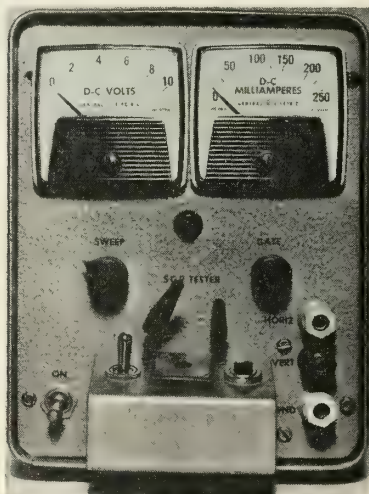
## ...products and processes

these adapters allow for a variety of uses far wider than being used in conjunction with flexible shafting alone. The drives have an ultimate static torque capacity of 25 lb. in. with a backlash of 6°. They weigh 4 oz. and 3½ oz. respectively. Furnished in gear ratios of 1:1, 1:2, and 2:1, other ratios are available upon special request.

Circle No. 234 on Subscriber Service Card

## Control Rectifier Tester

Power Sources, Inc., is marketing a silicon control rectifier-tester. A sweep supply, a gate supply and a divider for horizontal and vertical are incorporated. The variable sweep supply provides 0-500 volts; the variable gating supply

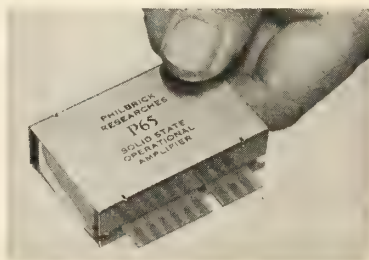


0-7 volts. Vertical output is 50 mv per ma. Horizontal output is 1 volt out for every 5 volts across the unit under test. The unit will test forward leakage, reverse leakage, gate voltage and gate current.

Circle No. 235 on Subscriber Service Card

## Differential Amplifier

Philbrick Researches, Inc. is marketing the P65 Differential Operational Amplifier. A miniturized plug-in, the P65 has a direct-coupled input circuit with a differential input of 10 volts and com-

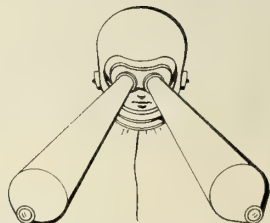


# Farrand



## STELLAR NAVIGATION SYSTEM OPERATES ACCURATELY . . . EVEN IN DAYLIGHT AT SEA LEVEL

In the science of navigation, Farrand pioneered the only working daylight image orthicon star tracker which operated on stars of +3.0 visual magnitude with 2 arc second accuracy at sea level. These trackers were first used in the Polaris Missile program in 1957. Farrand has since advanced the state of the art in miniaturized stellar-inertial navigation systems.



## OVERLAPPING MONOCULARS GIVE UNIQUE VISUAL CAPABILITY

The Overlapping Monoculars is a unique invention developed and manufactured by the Farrand Optical Company. The device preserves man's wide, unaided field of view in periscopic instruments without any variation of magnification across the field of view. The small entrance pupils, the wide, linear, uninterrupted field of 140° horizontal and 90° vertical, extent and its relatively light weight make this instrument particularly attractive to space tasks.

## METROLOGY

Where alignment, position readout or associated mensuration problems exist, Farrand Optical Company offers a complete line of off-the-shelf items such as alignment telescopes, vertical levelling mirrors and a host of associated equipment.

Farrand's activities in the area of electronic and optics can only be very lightly covered in these few examples. A multitude of Farrand designs in communications, optics, sights, trackers, photography, detection, navigation, television and many other fields are covered in our NEW CAPABILITIES BROCHURE. SEND FOR YOUR COPY TODAY.

# Farrand

**OPTICAL CO., INC.**  
Bronx Blvd. and East 238th St.  
New York 70, New York

Circle No. 32 on Subscriber Service Card

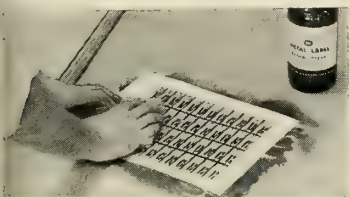


# 3M Materials Memo

News of materials for the aerospace industry — selected from the 27,000 products of the 3M Company

## A SIGN OF THE TIMES

In this troubled old world full of bad omens and forebodings of doom, a good sign is a mighty welcome thing. Even when that sign is only an aluminum emblem or identification plate, it's gratifying to know that it can be made — and will perform without causing you grief. In fact, we'll go a step further to say that making and using sign plates from our "Scotchcal" Brand Photosensitive Metal Label is a real breeze. With it, you can literally bring the metal label making capability in-house, where you've got full control. No more delays or premium charges because yours is a low quantity order. Best of all, you can have this capability without investing in a raft of special equipment.



Here's how it works. Using conventional photo-copy techniques, you make a positive or negative film from your original art. (Even without a camera, you can still make direct or reverse copy films from your original with "Scotchcal" Brand Photosensitive Exposure Film by direct contact printing.) From here on, it's just a simple contact printing routine on the metal label using most any ultra-violet emitting light source. Development is merely a matter of swabbing the label surface with a single solution. What's more, no darkroom is needed. "Scotchcal" Brand Metal Label can be safely handled in subdued light.

To apply the finished label to a clean dry surface, you strip the protective liner from the back of the adhesive, press it in place and that's it. The result is an aluminum label that's durable and weather resistant. It's high in fade resistance and stands up well to gasoline, oil and other hydrocarbons as well. Sign up for the full story.

## UNSTABLE DIMENSIONS YOUR PROBLEM?

When those dimensions are personal ones like the distance around the midriff, there's cause for irritation — but certainly not alarm. A generous portion of fill (or won't) power will usually bring things back in line. But in precision templates, patterns or even chart grids, dimensional variance can easily scuttle

the whole operation. Here the answer lies not in control, but in picking the proper stock material in the first place.

### PHYSICAL PROPERTIES OF TEN MIL FILM TENSILE AND ELONGATION

| Lengthwise Direction              |       |
|-----------------------------------|-------|
| Yield point (lb./inch width)..... | 129   |
| Elongation at yield point %.....  | 4.0   |
| Break point (lb./inch width)..... | 208   |
| Elongation at break point %.....  | 110.2 |
| Crosswise Direction               |       |
| Yield point (lb./inch width)..... | 158.5 |
| Elongation at yield point %.....  | 4.3   |
| Break point (lb./inch width)..... | 200   |
| Elongation at break point %.....  | 160   |
| MULLEN BURST TEST                 |       |
| Pounds per square inch.....       | 445   |

Where precise printed impressions are concerned, it's pretty hard to beat our PRINTING PRODUCTS DIVISION's "Scotchprint" Brand film. Made in calipers ranging from 2-10 mils, it's in a class of its own in dimensional stability. The change in any direction is less than  $2.0 \times 10^{-5}$  inches/inch for each °F or each % change in relative humidity. Printability too is top notch — either on "Scotchprint" in an opaque paper-like form or as a translucent material. What's more, these impressions can vary all the way from delicate lines to half tones and solids. Like to see "Scotchprint" with a light sensitive coating — or a pressure sensitive adhesive? It's no problem.

"Scotchprint" film is a rugged performer too in quite a few ways. As a 10 mil film, it has a break point of 208 lbs./in. width. It resists even boiling water, mildew, oil, many solvents and chemicals — and repeated creasing won't crack it. Check the coupon below to learn how "Scotchprint" can keep your problem in its proper proportions.

## TO BOND OR NOT TO BOND?

"To be or not to be, that is the question." In Shakespeare's day, they rattled

swords. Today they rattle missiles. Now the question becomes, "To bond or not to bond?"

"Reduce the weight and increase the strength" is the "hue and cry" in both aircraft and missile design. This means thin, strong, and often stressed skins subjected to maximum loads and extreme fatigue. Traditional methods of metal joining just won't meet the need. So — it's research to the rescue with the chemical bond.



A new technical brochure, available from our ADHESIVES, COATINGS & SEALERS DIVISION, presents the principles of structural bonding. It points out that mechanical fasteners (bolts, rivets, etc.) require holes which weaken skins and result in stress concentrations. Welding and brazing can ruin heat treatments or distort parts. Conversely, structural adhesives distribute loads evenly over joint areas, seal as they join, and open new horizons of fatigue resistance. As an added bonus, the 12 page brochure contains a packet of data sheets on the 3M structural adhesives that helped change the old art of adhesive bonding to the new tool of the structural engineer.

If you would like a copy of this "Scotchweld" Brand Structural Adhesive brochure, check the box below or ask for one from your local ADHESIVES, COATINGS & SEALERS DIVISION representative.

Missile Industry Liaison — Dept. VAB-111  
Minnesota Mining & Manufacturing Company, St. Paul 6, Minn.  
Please send more information on:

- ☐ "Scotchcal" Brand Photosensitive Metal Label    ☐ "Scotchprint" Brand Film  
☐ "Scotchweld" Brand Structural Adhesive  
☐ Start sending me your bi-monthly "Materials Memo" Bulletin

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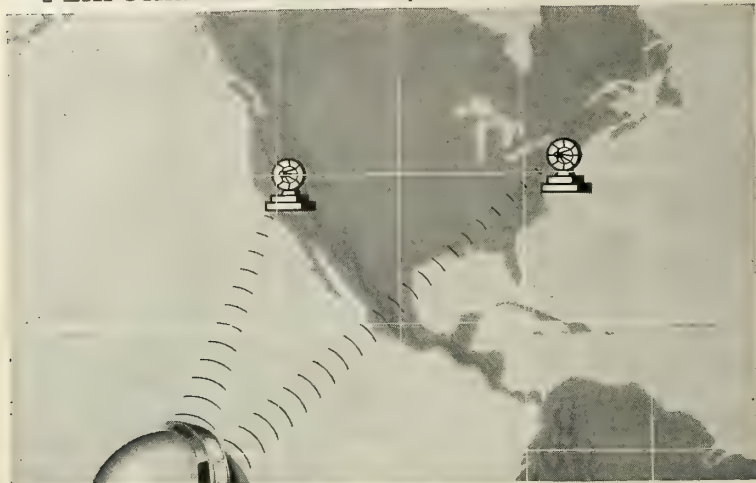
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"SCOTCHCAL", "SCOTCHWELD", AND "3M" ARE REGISTERED TRADEMARKS OF 3M CO., ST. PAUL 6, MINN.

## Missile Industry Liaison

**3M**  
COMPANY

## PERFORMANCE REPORT / PROJECT ADVENT



**ASSIGNMENT:** design, build, manufacture, install and commission two entire ground control stations under direction of the USAAMA and Sylvania Electric Systems division. **TOLERANCES:** critical beyond precedent! Radar accuracy to within 0.002° of arc, despite temperature expansion of metal components. **SCHEDULE:** completion within one year from declaration of intent! **PROGRESS:** first phase delivered 3 weeks early; current phases on schedule. **SUMMATION:** successful execution on our portion of Project ADVENT demonstrates the ability of Ets-Hokin & Galvan to handle challenging and difficult projects. Call us, at any of these locations, for full information on our capabilities.



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PERFORMANCE NOW FOR SPACE AGE DEMANDS

Circle No. 33 on Subscriber Service Card

## How good is OPTISYN®?

Here are some of the facts...

you be the judge.

OPTISYN is an incremental shaft-angle transducer, capable of generating 2048 (or more) precisely-placed counting pulses per input shaft revolution in tiny Size 11 (1.1 inch case diam.); over 4000 counts per turn in larger sizes. OPTISYN has no gears, no sliding contacts. It can produce 100,000 reliable pulse counts per second, at shaft speeds up to 30,000 rpm! Counters have trouble keeping up with OPTISYN.

**WHAT'S THE SECRET?** OPTISYN is based on a unique OPTICAL GEARING principle that results in 4-times increase in resolution, dependable wide-aperture optics, and valuable error-averaging. Accuracy and reliability are the result. OPTISYN is standard equipment on Titan missile, offers 6 years mean-time-to-failure, and ruggedness to meet MIL-E-5272C.

**VARIATIONS?** Special designs, including pancake shapes, are in production for inertial accelerometers, gyro gimbals, pedestal mounts, industrial uses, etc. Output electronics also available to match high-performance OPTISYN into your digital system. Want more information?



Sizes 11, 23, and 27 in growing OPTISYN line.



**DYNAMICS  
RESEARCH  
CORPORATION**

38 MONTVALE AVENUE STONEHAM, MASS.

Tel. 438-3900

*Inertial and Industrial Control System Specialists*

Circle No. 34 on Subscriber Service Card

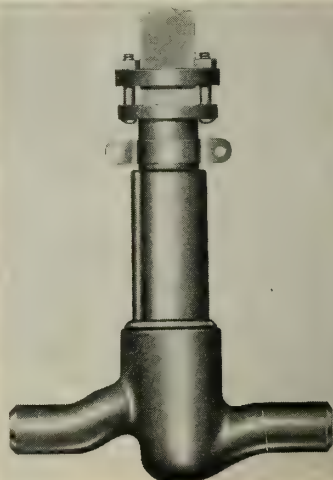
## ...products and processes

mon mode rejection of about 10,000 to 1. Input current is approximately  $10^{-7}$  amperes, which can be balanced out to  $10^{-8}$  amperes with external circuitry.

Circle No. 236 on Subscriber Service Card

### Hot Helium Valve

A hot helium valve, designed to operate at temperatures up to 1600°F, is available from Security Valve Co. Valves come either in solid body angle or globe pattern and feature all-welded



construction. Additional features include bellow seals, auxiliary stuffing box and vent connection. This new valve is available in all ASA ratings and sizes as well as a wide range of standard and special body connections.

Circle No. 237 on Subscriber Service Card

### One-Megacycle Flip-Flops

Navigation Computer Corp. is marketing the M10 One-Megacycle Flip-Flop Module. This basic module has five identical flip-flops which will operate as a counter at rates up to 2 megacycles. Each flip-flop has a neon indicator. Together with a Model M11 Interstage Delay Module, the M10 forms a parallel-entry adder which will complete a 5-bit addition in a maximum of 4 microseconds. The sum in the adder can be shifted for serial-parallel multiplication.

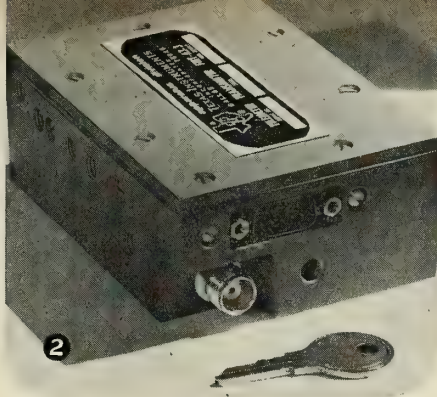
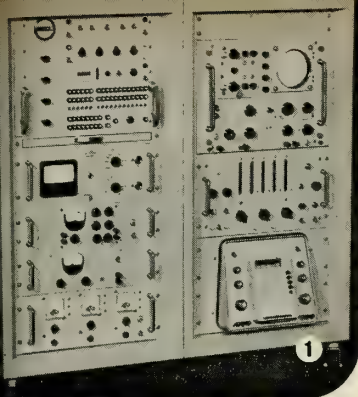
Circle No. 238 on Subscriber Service Card

### Explosion-Proof Switch

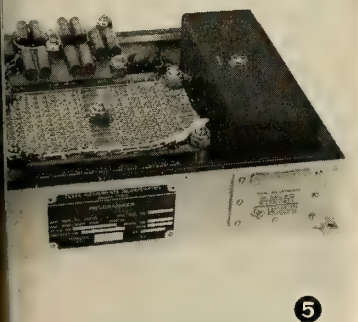
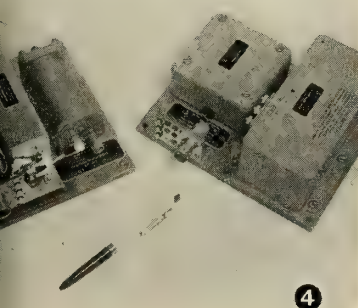
The Model 610GE Explosion-proof Pressure Switch is being marketed by Custom Component Switches, Inc. The unit is only  $\frac{1}{4}$  the size of similar switches currently available. The Model

missiles and rockets, November 27, 1964



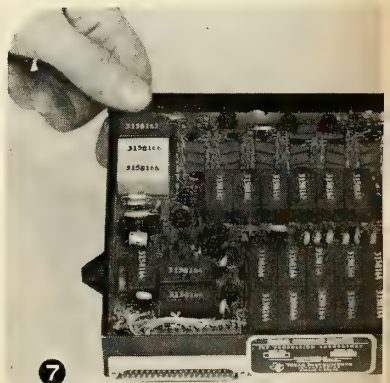
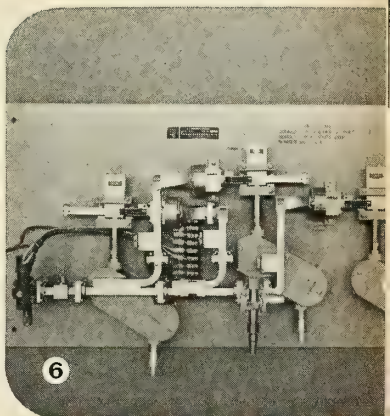


# HERE'S HOW TI SOLVES SPACE COMMAND/GUIDANCE PROBLEMS



With **experienced systems engineering staff—complete manufacturing capability—product-proved research and development laboratories—plus time-tested equipments** now operational, some of which are:

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2. Solid-State FM/FM Telemetry Transmitters operated in Mercury spacecraft flights.
3. Flight Data Encoder uses high/low-level PCM telemetry system . . . with  $\pm 0.5\%$  accuracy, nulled-out drift. A similar 70-channel system has been supplied to Jet Propulsion Laboratory for Mariner A.
4. Solid-State UHF Beacon Transponder made possible missile tracking by MIT Lincoln Laboratories Millstone radar.
5. Digital flight controller/programmer in Douglas Aircraft's Delta Launch vehicle helped orbit NASA weather satellites Tiros II and III, communication satellite Echo I, space probes Explorer X and XII.
6. 3-Channel Parametric Amplifier—Low-noise operation for C-Band monopulse satellite tracker for Bell Telephone Laboratories.
7. Digital Command Decoder for Ranger 3-5 lunar probes.



For information on your specific command/guidance requirements, contact **MARKETING DEPARTMENT.**

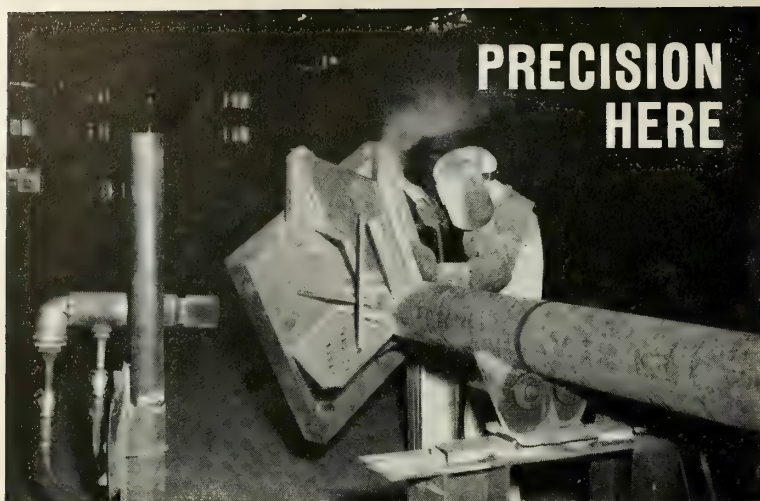
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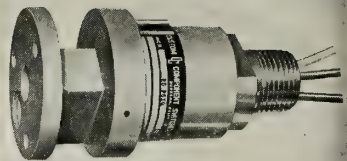
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...products and processes

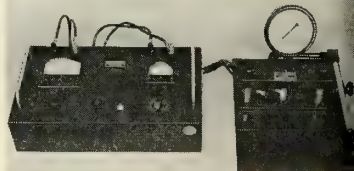


610GE is listed by Underwriters' Laboratories, Inc. for use in hazardous locations Class I Groups A,B,C and D as well as Class II Groups E,F, and G. The CC Dual-Snap switch design provides a positive setting and eliminates drifting of actuation point due to varying temperatures. The CC Dual-Snap switch is not affected by pump ripple or pulsation.

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## **Surface Resistance Tester**

In instrument which checks cleanliness of aluminum or other metals prior to welding by measuring the surface resistance in microhms is available from J. W. Dice Co. A low surface resistance

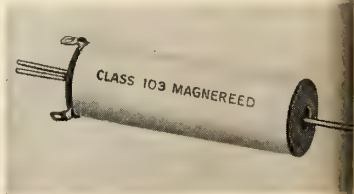


shows that oxides or other contamination have been properly removed and that the material should weld properly. The unit operates on 115 volts, a-c and meets Mil-spec 6858-A. The test jig is hydraulically operated and its capacity range of 0-2000 lbs. permits duplication of the actual pressures used for the welding operation.

Circle No. 240 on Subscriber Service Card

## **SPDT Relay**

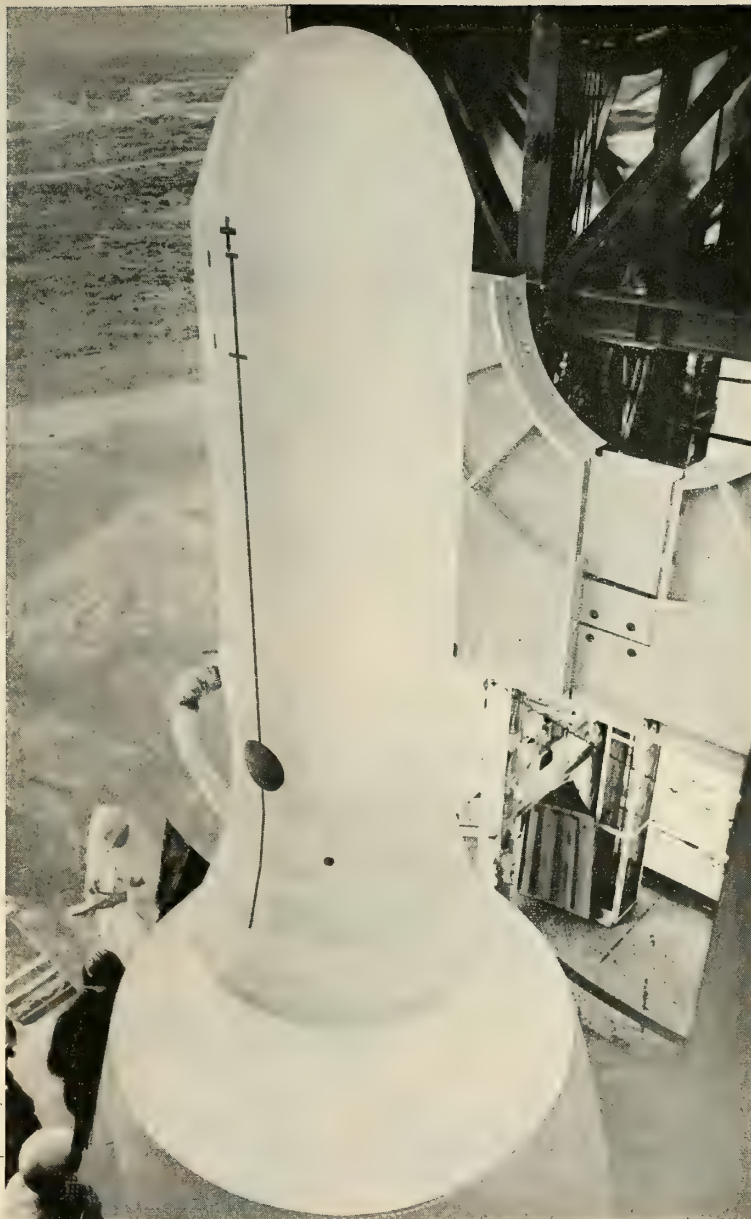
Fast switching and stable contact resistance over long life are combined in a single-pole, double-throw, reed type relay designated Magnereed Class 103, available from Magnecraft Electric Co. The entire switch element, including gold SPDT contacts, is hermetically sealed.



missiles and rockets, November 27, 1964



HITCO-  
developed  
fabrication  
techniques  
are  
now  
providing  
portions  
of  
the  
heat shield  
for  
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Atlas  
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nose cones



#### ABLATIVE MATERIALS ENABLE FIRST ICBM NOSE CONE RECOVERY

This RVX1-5 was the first nose cone to travel full ICBM range and be successfully recovered intact. Speeds up to 15,000 mph, temperatures to 12,000°F, high heat inputs, and high acceleration and deceleration forces were encountered. The RVX1-5 was enabled to withstand these severe re-entry conditions through the use of REFRASIL<sup>1</sup> and AVCOITE<sup>2</sup> ablative heat shield materials.

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REFRASIL is a registered trade mark of H. I. THOMPSON FIBER GLASS CO. AVCOITE is a registered trade mark of the AVCO CORPORATION.



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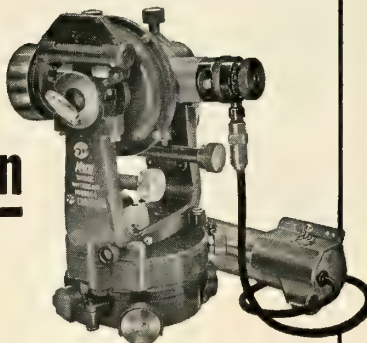
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## ...products and processes

metically sealed inside a glass capsule in an atmosphere of inert gas. The contacts are actuated magnetically by a coil around the glass switch capsule. The construction is extremely simple and the relay is readily adaptable to all kinds of mechanical configurations.

Circle No. 241 on Subscriber Service Card

## Waveguide Switch

A new approach to the internal choke design of a waveguide switch has enabled NRK Microwave Division of Cook Electric Co. to develop a high-power miniature waveguide switch which is smaller in size yet comparable in performance to conventional switch-



es. NRK Microwave is marketing switches of this design to cover the frequency range from 5.85 to 18 Gc. The X-band switch for use with RG67/U guide has a maximum VSWR of 1.10:1 minimum isolation of 50db and 0.10 db insertion loss and 250 KW peak power handling capability at 1 atmosphere from 8.5 to 9.6 Gc.

Circle No. 242 on Subscriber Service Card

## Static Frequency Changer

A 10-KVA, 3-phase, 115/200-volt static frequency changer is available from Precision Power Division of American Electronics, Inc. Operating from a 60-cycle 220 or 440-volt source, Model 361-102-103 frequency changer provides fixed or continuously variable

missiles and rockets, November 27, 1961



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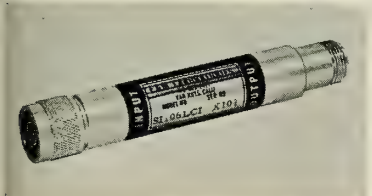


output frequency of  $400 \pm 50$  cycles and variable output voltage of  $115 \pm 15$  volts. The unit is capable of maintaining both the output frequency and voltage at any setting to within  $\pm 1\%$  under conditions of changing output load from no load to full load and changing input frequency and voltage of  $\pm 5\%$ . Average harmonic content is 3% with a maximum harmonic content of 4%.

Circle No. 243 on Subscriber Service Card

## Coaxial Isolator Line

E & M Laboratories is marketing a series of lightweight coaxial isolators. These isolators are lightweight units which meet MIL specification standards



over a temperature range of  $-30^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . Standard units are available in the frequency range of 0.95 KMC to 3.1 KMC. A typical unit is the 2.2 to 2.3 KMC isolator which is 5.0 in. long, weighs a maximum of 6 oz.

Circle No. 244 on Subscriber Service Card

## D-C Preamplifier

Cohn Electronics, Inc., Kin Tel Division, is marketing a differential d-c preamplifier, floating and narrow-band, for general use. The Kin Tel 459 C/N, with the gain set at  $-100$ , extends the range of Kin Tel Digital voltmeters to 1 microvolt d-c and pro-



vides stable, accurate amplification of low level input signals in the presence of high common mode noise and hum. Common mode rejection is 180db for 1-c and 130db for 60 cps with up to 1000 ohms unbalance in either signal lead.

Circle No. 245 on Subscriber Service Card

## Ballistic Plate Developer

A transportable, Semi-Automatic Film Developer that can be used in either lab or field work, has been designed by Instrument Corp. of Florida. The instrument permits the unloading of cassettes in daylight, thus eliminating the need for darkrooms. The compact, lightweight developer features indicator lights on panels for visual determination

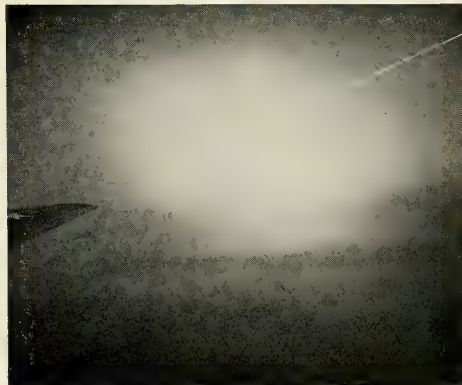
missiles and rockets, November 27, 1961



Spectacular as it is, a Titan take-off from Canaveral is only one end of the story. Moments after the shoot, nine thousand miles downrange, an airborne monitoring team is alerted to record the other end of the story as the re-entry vehicle plunges into the atmosphere at 15,000 mph.

Aboard the re-entry monitoring aircraft, a battery of photographic, photoelectric, and radiometric devices captures the dramatic end of the flight. A P.I. instrumentation tape recorder, operated by an Avco-Everett Research Laboratory monitoring team, is used to preserve on magnetic tape a precise record of important radiometric and time-sequence information...data which is essential in the development of advanced re-entry vehicles and in the country's anti-missile program.

One reason a P.I. recorder was selected for this program is that it provides full-size instrumentation performance in a fraction of the space. You'll be interested, if you record any type of scientific data, in other characteristics of P.I. recorders. For details, write for our current brochure.



Above — Photo of Titan missile re-entry. Below — Recorder installation aboard the monitoring aircraft. Photos courtesy of Avco-Everett Research Laboratory.



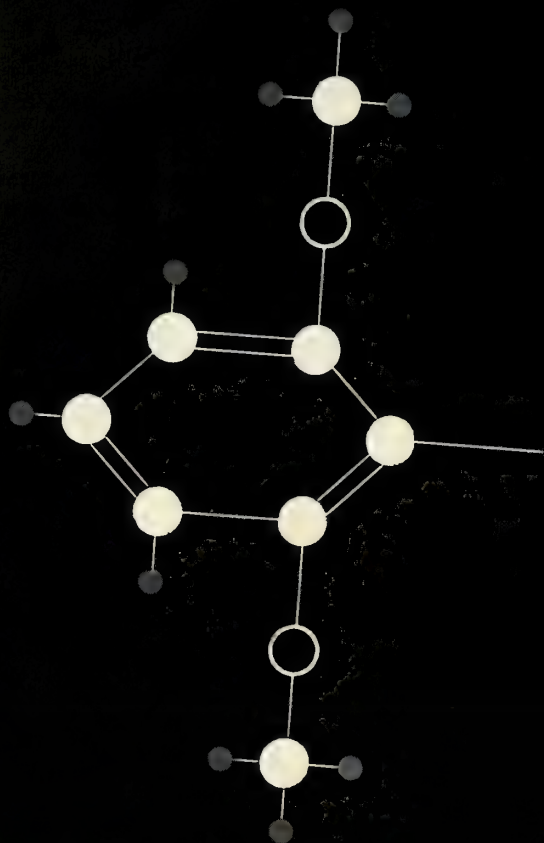
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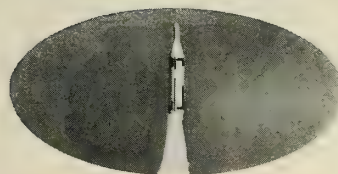




#### NATIONAL WATER LIFT COMPANY DIVISION

##### Subject: Servo-Valves

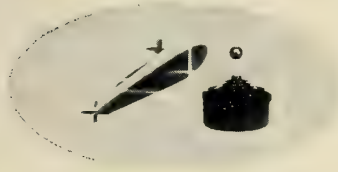
Pitch, Yaw, Roll, Control System / Mercury Capsule / Designed / Developed / Produced.



#### SYSTEMS ENGINEERING DIVISION

##### Subject: Thrust Vectoring

Thrust Vector Control System under Development for Polaris Missile Application.



#### INSTRUMENTATION AND CONTROL DIVISION

##### Subject: Two-Axis Controller

Controller for X-Y Coordinates of Two-Axis Control System Designed/Developed/Produced for Nortronics/for Control System of Polaris Submarines.



#### ADVANCED SYSTEMS DEVELOPMENT DIVISION

##### Subject: Imbedment Anchors/Sea Staple

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Thrust Vectoring Systems / Flight Control Systems / Actuation Systems / Servos / Gyros / Advanced Air Vehicle Crew Station Design / Special Instrumentation Display Systems / Space Vehicle Landing Gear / Accelerometers / Flow Meters / Two Axis Controls / Marine Systems / Ship Replenishment Systems / Oceanographic Instrumentation and Surveys / Shipboard Handling Equipment / ASW Systems Design and Installation / Ship Positioning Systems / Deep Water Mooring / Hydrofoil Design / Ground Effect Vehicles / Underseas Systems Engineering / Thermocouples

**PNEUMODYNAMICS CORPORATION**



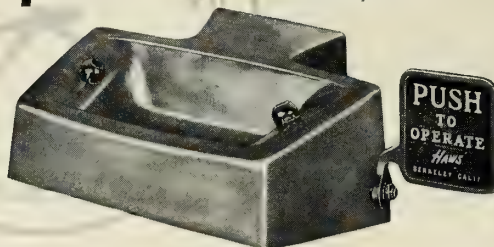
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Cast aluminum receptor;  
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FOR THE FIRST TIME

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In Precision Instrument Switches — Through accurate, automatic alignment with low drag

**CHANGEABLE DECKS** — Captive Rotor gives integrated deck assembly — Switch can be disassembled, wired, decks exchanged, reassembled — quickly, easily, with common socket wrench.

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**FREE** — Write today for 24 page Guide to Choosing Precision Instrument Switches

This switch  
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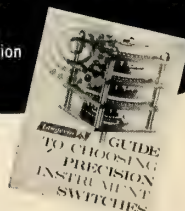
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Circle No. 36 on Subscriber Service Card



## ...products and processes

of the various stages of development process. An adjustable timer permits developing from 30 seconds to 7 1/2 minutes—1 minute for shortstop—up to 15 minutes for hypo—and 15 minutes to an indefinite time for wash. A dryer is also incorporated into the unit.

Circle No. 246 on Subscriber Service Card

## Low Level Multiplexer

A transistorized Multiplexer capable of commutating differential or single ended input signals from 0 to + 15 volts, with a resolution to one microvolt is available from Alpha-Tronics Corp. Over variations in source impedance of 0 to 10K ohms and -20°C to + 85°C, the offset voltage of the Multiplexer does not exceed 50 microvolts and the saturation resistance is less than 40 ohms. The unique sequencer employed guarantees that two switches cannot be gated simultaneously, even with a component failure.

Circle No. 247 on Subscriber Service Card

## Cryogenic Level Control

Powertron Ultrasonics Corp. is marketing the Sonoswitch, Model UP 1015, that affords complete automatic control for all cryogenic liquid control applications. The stainless steel probe instantly activates when any cryogenic liquid touches its sensitive probe surface. The unit has repeatability within thousandths of an inch and is not affected by clinging droplets. The ultrasonic probe, capable of operating at a pressure over 2000 psi, does not actuate in either foam or froth and requires no adjustment for temperature shifts or pressure variations.

Circle No. 248 on Subscriber Service Card

## Accelerometer Switch

For measurements of steady-state acceleration, Humphrey, Inc. has developed the AS31 series Accelerometer Switch. The unit offers rapid response time to steady-state accelerations together with insensitivity to low frequency vibration. This performance was achieved by incorporating a high damping factor and a low natural frequency into the design. Reliable operation over a wide temperature range is ensured by the use of temperature-stable air dampers and flexure suspension. The AS31 Series of accelerometer switches covers ranges of  $\pm 1G$  up to  $\pm 50 G$ 's and may also be made for even higher ranges.

Circle No. 249 on Subscriber Service Card

## Pulsed X-Ray System

A multiple pulse X-ray system capable of charting the performance of

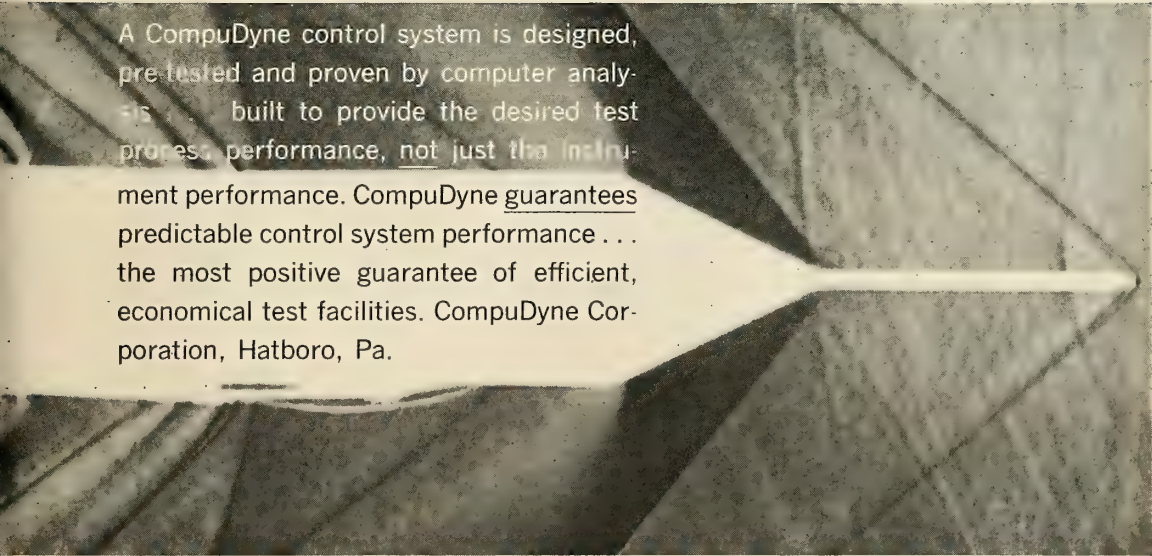
missiles and rockets, November 27, 1961



## DATA, DOLLARS AND TIME:

Each is a vital factor in the accelerated program to increase performance efficiency of missile and aeronautical test facilities. CompuDyne control systems apply dynamic control to critical variables inherent in aerodynamic structural and other test procedures to promote the output of more information, in a more useable, valid form—at a fraction of the time required with costly steady-state systems.

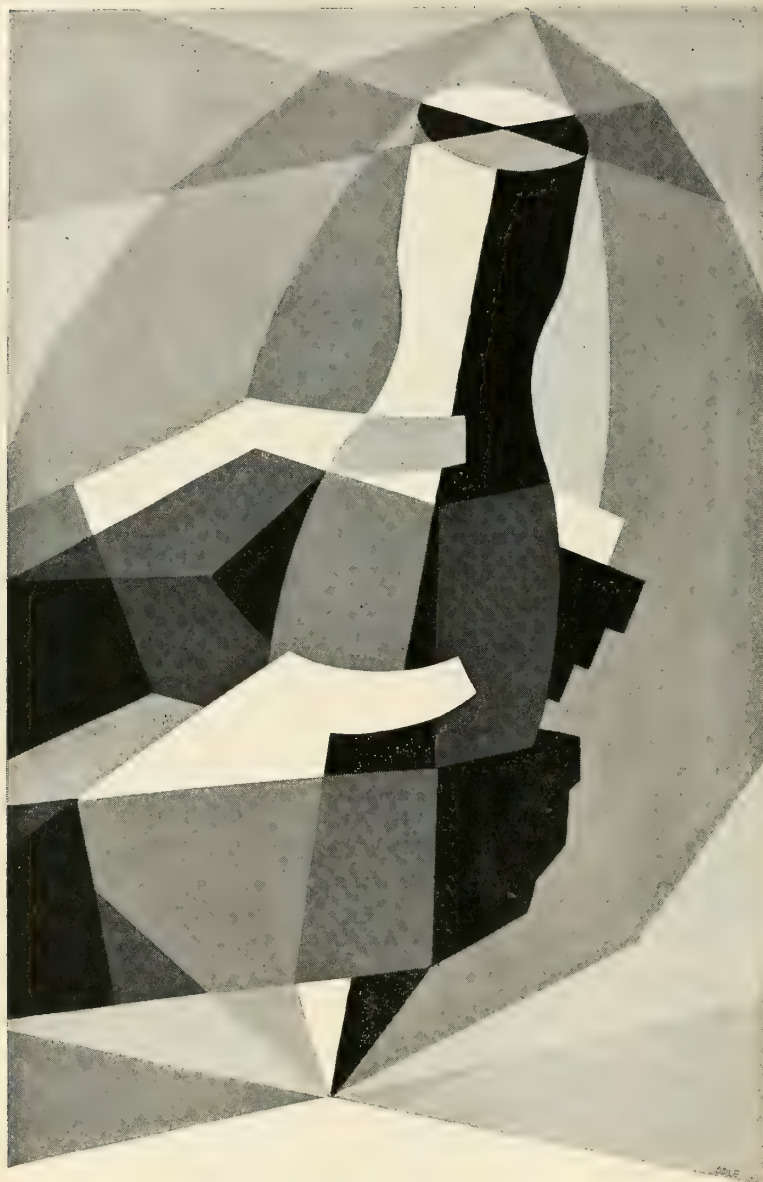
Thus, a CompuDyne control system in a blow-down wind tunnel integrates precise, dynamic control of air velocity and pressure with a programmed positioning sequence of the model being tested. Result: greatly increased data output per test run. Equally effective results have been achieved for many NASA installations using CompuDyne systems including rocket engine test cells, structural load test facilities, space environmental and sonic test facilities, and missile fuel loading equipment.



A CompuDyne control system is designed, pre-tested and proven by computer analysis . . . built to provide the desired test process performance, not just the instrument performance. CompuDyne guarantees predictable control system performance . . . the most positive guarantee of efficient, economical test facilities. CompuDyne Corporation, Hatboro, Pa.

**CompuDyne Corporation** manufactures computer-operated automatic control systems and related electronic, hydraulic, and mechanical instrumentation for the aircraft, missile, space, and industrial process fields.

Circle No. 103 on Subscriber Service Card



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61-T-6

## ...products and processes

totally enclosed moving parts is available from MB Electronics. The pulsed X-ray system was developed by Zenith Radio Research Corp. It is being marketed in the environmental testing field by MB. The depth studies now possible should be instrumental in developing new information and techniques of value to the environmental engineer. The end result should be increased product reliability through decreased test time and expense.

Circle No. 250 on Subscriber Service Card

### Cycle Counter

A combination portable unit, designed for high-speed time interval and cycle counting, is available from Astro-Space Laboratories, Inc. It uses transistorized, printed-circuit plug-in modules, with a crystal-controlled oscillator for stable time base. The TC-1 has a self-contained power supply. Input signals may be from a photohead or from auxiliary sources. Operating range of the timer is preset via counter response, over a time interval of 999,999 seconds in 1 msec. steps. Maximum repetition rate of the preset counter is 110 kc, with a capacity of up to 999 cycles.

Circle No. 251 on Subscriber Service Card

### Wire-Fed Torch

A wire-fed 22-oz. welding torch, is available providing significant improvements in maneuverability and coolness. Developed by the Westing-Arc Department, Westinghouse Electric Corp., the straight-through torch, Model HT-1 has a rated 100% duty cycle of 200 amps, and accommodates wire sizes from .030 in. to .047 in. It can be used with CO<sub>2</sub> in the reactor and spray ranges, and with argon or argon gas mixtures in the reactor range. A nozzle-seat design allows 360° rotation about the handle without using tools.

Circle No. 252 on Subscriber Service Card

### Nitrogen Level Control

A system for controlling the level of liquid nitrogen in cold traps, and other low-temperature vessels, is available from Cryogenics, Inc.

The Cryotrol is designed around a



missiles and rockets, November 27, 1961



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## NOTICE TO MISSILE SYSTEM SUPPLIERS

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Any equipments or components you are producing for missile weapons systems can be analyzed for Radio Frequency Interference by Capehart's INTERDICT\* Group. Under our analysis procedures, RFI is computer-predicted on finished products, prototypes, or preliminary designs. Every item of electronic equipment which produces radiated or conducted RF signals is considered a transmitter, and every electronic equipment which is subject to malfunction as a result of exposure to conducted or radiated spurious signals is considered a receiver.

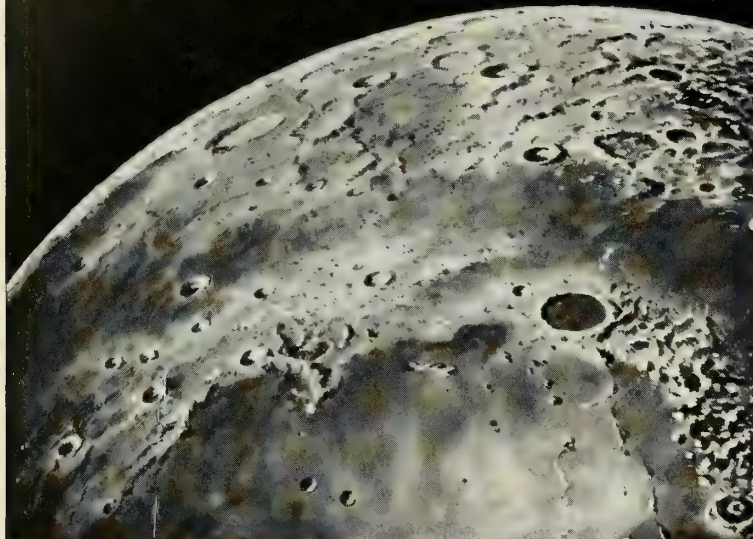
We will make specific recommendations and provide design changes to bring your equipment within the RFI specifications or inform you if it is already within standards. Capehart's INTERDICT Group performs this same service for any other type of installation, site or system where RFI may be a potential problem. Our approach in RFI diagnosis of over-all operational requirements utilizing computer programming has been proven on a number of electronic equipments, missile systems and military sites including Cape Canaveral and Vandenberg AFB.

*\*Interference Detection and Interdiction by Countermeasures Team*



INTERDICT GROUP, Dept. R, CAPEHART CORPORATION  
87-46 123rd Street, Richmond Hill 18, New York • Hickory 1-4400

# Can a Computer Recognize MOON GEOGRAPHY?



• Cornell Aeronautical Laboratory's engineers and scientists are investigating concepts for computers which can be "taught" to recognize patterns, whether those patterns be airfields, gun emplacements, or even significant topographic features of the moon. Equally important, some of the special purpose computers under development in related areas are surprisingly small, yet faster for the task than the speediest general purpose computers in use today. These computers use novel delay line storage techniques to perform computations in real time. Other related computer sciences activities include analytical and experimental research in data processing techniques, adaptive control systems, and trajectory tracking techniques.

But CAL's pioneering effort in space technology extends into other areas as well. For example, the hypersonic tunnel facilities are among the nation's most exacting and complete for simulating hypersonic flight in the earth's atmosphere. The wave superheater tunnel will produce high temperatures for relatively extended periods (up to 15 seconds), while the shock tunnels extend CAL's research and testing capabilities to duplicate orbital re-entry for relatively brief periods (up to 10 milliseconds).

Our technical team is also making pace-setting strides in electronic packaging for payload development, experimental programs for space propagation research, and wind-shear measurements for launch aid. If you would like to know more about the research capability of this not-for-profit laboratory write or wire J. J. O'Neil. If you believe you are qualified to join the team write Jack Rentschler.



**CORNELL AERONAUTICAL LABORATORY, INC.**

of Cornell University, Buffalo 21, New York

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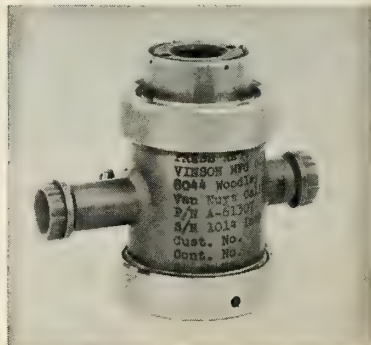
## ... products and processes

unique upper-lower limit sensor mounted in a suitable probe configuration which may be attached to cold traps and process devices. When the level of liquid in the cold trap drops below a pre-determined lower limit, the controller actuates a solenoid valve which in turn initiates transfer of liquid into the cold trap until the pre-determined upper limit is reached. The solenoid control valve is the de-energized and the transfer stopped.

Circle No. 253 on Subscriber Service Card

## Gas Regulator

Extremely narrow flow to lockout band, high reliability, and accuracy over broad time lapses have been achieved in a gas regulator available from Vinson Mf. Co. It is compatible with most space fuels and has a temperature range from  $-100^{\circ}\text{F}$  to  $550^{\circ}\text{F}$ . In a typical performance with metal seats, inlet



pressure range is 200 to 3600 PSIG, regulated pressure 87 PSI at 2.0 SCFM minimum. Lockout pressure is 104 PSI at 0.5 standard cc per minute maximum. With soft seats, a typical inlet pressure range is 250 PSIG to 4000 PSIG; regulation is adjustable from 125 to 190 PSIG; regulated pressure is 183 PSI at 2.0 SCFM; lockout pressure is 187 at 0.5 standard cc per hour.

Circle No. 254 on Subscriber Service Card

## Flat-to-Round Adapter

An adapter device for interconnecting flat conductor cable with conventional round wire is available from The Thomas & Betts Co. An addition to their line of Pos-E-Flex flat cable connectors, this round wire adapter simplifies the introduction of flat cable to existing electrical and electronic equipment wiring systems. The connector makes the use of flat conductor cable a practical reality for low-voltage control wiring, intercom systems and remote control wiring.

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missiles and rockets, November 27, 1961



## SCIENTIST-MANAGER PhD Physics

Applications of Ion, Arc Jet,  
MHD and Other Advance Engines to  
SPACE PROPULSION SYSTEMS

One of the most challenging assignments in space technology—the application of very advanced engines to provide capability for space maneuver and deep space propulsion. This scientist will lead a small group of specialists. Requires doctoral degree in Physics and minimum of 8 years applicable experience, with 2-3 of these in electric propulsion R&D.

1

## Diversified Assignments in Systems Engineering

### SYSTEMS DESIGN Navigation & Control

Challenging opportunity for engineer capable of assuming responsibility for integration, coordination and project engineering of special navigation and control systems. These include satellite attitude control, orbit control, space power. Work requires a broad background in controls; 5 or more years engineering experience; EE or ME.

### SYSTEMS ANALYSIS Varied Space Systems

Conduct preliminary studies to optimize space systems through subsystem trade-offs, in order to provide a balanced systems synthesis effort. Define performance requirements and specific interface relationships between sub-systems. Degree plus 4 or more years experience in systems analysis required.

## Research Associate Interplanetary and Lunar Trajectories

Conduct analytical and computer studies in applied mechanics, applied mathematics, celestial dynamics and analytical dynamics. Requires PhD in any of the following: Mathematics, Astronomy, Applied Mechanics.

## CONSULTANT Space Structures

Sought: A high calibre engineer/scientist to advise, recommend and implement long range programs in space structures... able to contribute creatively well beyond current state of the art. Advanced degree preferred.

## MANAGER Advanced Space Power R&D Thermionics, Fuel Cells, Photovoltaics

A creative scientist with leadership abilities to guide a group responsible for advancing the state of the art in the urgent field of power, energy and storage systems for spacecraft and satellites. PhD preferred—advanced degree essential—in Physics, Chemistry or Mechanical Engineering with 8 years experience, 2-3 of these in Space Power. An outstanding opportunity for scientific achievement and personal progress.

1

## SR. STRUCTURAL DESIGN

Establish configuration D&D of re-entry vehicles, missile & space vehicles including application of new materials; determine design allowables and preliminary stress analysis. ME or AE plus 8-10 years structural design experience.

1

## IMMEDIATE OPENINGS AT THE MISSILE & SPACE VEHICLE DEPARTMENT

PHILADELPHIA, PENNSYLVANIA

Your inquiry is invited regarding any of the positions—encompassing more than ten areas of space science and engineering—listed on this page. Please use the INQUIRY CARD provided for your convenience. A prompt answer is guaranteed; your confidence will be respected.

## HUMAN FACTORS

Psychologist, MS, PhD, to solve intriguing man-in-space problems.

Simply circle the appropriate letters of those positions that meet your professional interests and qualifications, fill in the questions listed below—attach a resume if you have one handy—and airmail to:

Mr. Frank Wendt  
Missile & Space Vehicle Department  
General Electric Company  
3198 Chestnut Street  
Philadelphia 4, Pennsylvania

## I am interested in the following position(s)

Vehicle Engineering ..... B, V  
Navigation & Control ..... F  
Aerodynamics — Trajectories ..... P  
Thermodynamics — Aerophysics ..... L  
Systems Analysis ..... G  
Advanced Systems ..... F, G  
Ground & Space Support ..... K  
Applied Mathematics ..... P  
Space Power & Propulsion ..... A, J  
Analog & Digital Techniques ..... P  
Life Support ..... K

## PROFESSIONAL EXPERIENCE

(Two most recent or most applicable jobs)

Company \_\_\_\_\_

Position \_\_\_\_\_

Years of experience (from) \_\_\_\_\_

(to) \_\_\_\_\_ Salary \_\_\_\_\_

Assigned Duties \_\_\_\_\_

Company \_\_\_\_\_

Position \_\_\_\_\_

Years of experience (from) \_\_\_\_\_

(to) \_\_\_\_\_ Salary \_\_\_\_\_

Assigned Duties \_\_\_\_\_

## PERSONAL DETAILS

Name \_\_\_\_\_

Home Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_

Telephone \_\_\_\_\_

U.S. Citizen Yes ☐ No ☐

## Education

Undergraduate

College \_\_\_\_\_

Degree \_\_\_\_\_ Year of Graduation \_\_\_\_\_

Graduate

College \_\_\_\_\_

Degree \_\_\_\_\_ Year of Graduation \_\_\_\_\_

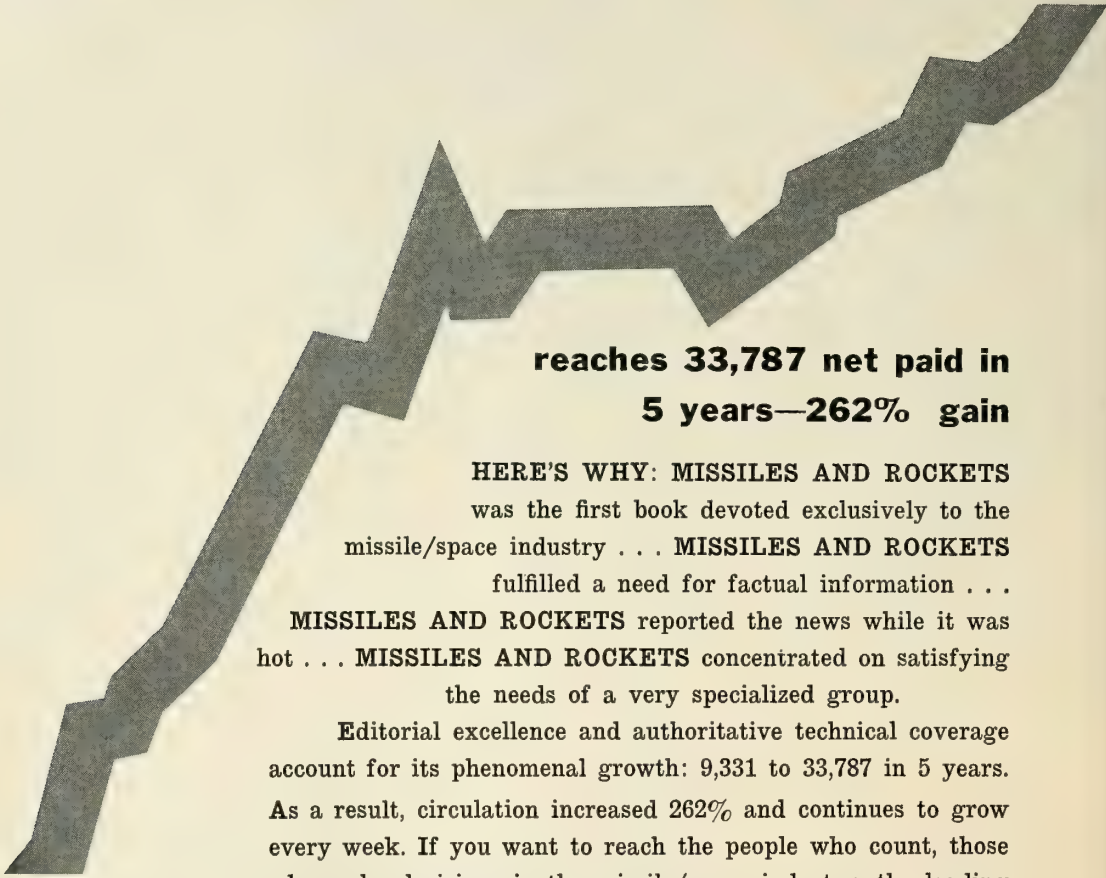
Position Objective (primary job preference, level of responsibility, salary expectations)

GENERAL  ELECTRIC

All qualified applicants will continue to receive consideration for employment without regard to race, creed, color, or national origin.

# CLIMB FASTEST RATE OF

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reaches 33,787 net paid in  
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HERE'S WHY: MISSILES AND ROCKETS  
was the first book devoted exclusively to the  
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fulfilled a need for factual information . . .

MISSILES AND ROCKETS reported the news while it was  
hot . . . MISSILES AND ROCKETS concentrated on satisfying  
the needs of a very specialized group.

Editorial excellence and authoritative technical coverage  
account for its phenomenal growth: 9,331 to 33,787 in 5 years.  
As a result, circulation increased 262% and continues to grow  
every week. If you want to reach the people who count, those  
who make decisions in the missile/space industry, the leading  
book is MISSILES AND ROCKETS.

\* Subject to audit

January, 1957  
9,331



## missiles and rockets

The missile/space weekly • An American Aviation Publication  
1001 VERMONT AVENUE, N.W., WASHINGTON 5, D. C.





## LETTERS

(Continued from page 10)

### Saturn Should Succeed

To the Editor:

Let me congratulate you on your Nov. 6 editorial ("Afterthoughts of a Saturnalia").

After the recent *Saturn* shot I feared those involved in the project were going to wind up with bursitis, a condition brought about by patting themselves on the back.

You are the only editor that I know of who has had the guts to write about this disgraceful display of self-love and self-congratulation.

I certainly do not, as I am sure you don't, want to detract one bit from the achievement of those engaged in our space activities.

But, on the other hand, I had been led to believe that America's greatest engineering minds and abilities were engaged in this work. Because of this, I expect successful shots to be the rule, failures the infrequent exception.

William H. Graffis  
Wilmette, Ill.

### Electronic Warfare

To the Editor:

We here at Hallicrafters, who are involved in electronic warfare, were very much impressed with your articles in the Sept. 25 M/R covering the electronic warfare market.

We felt that your coverage was an excellent job of reporting, and that you approached each detail for the present and future electronic warfare requirements very accurately.

As you well know, we see a great need for electronic warfare equipments in the protection of our manned and unmanned missiles for the future, and we sincerely believe that your articles will draw attention to these needs. . . .

Robert F. Halligan  
President  
The Hallicrafters Co.  
Chicago

### Further Re 'B, B & B'

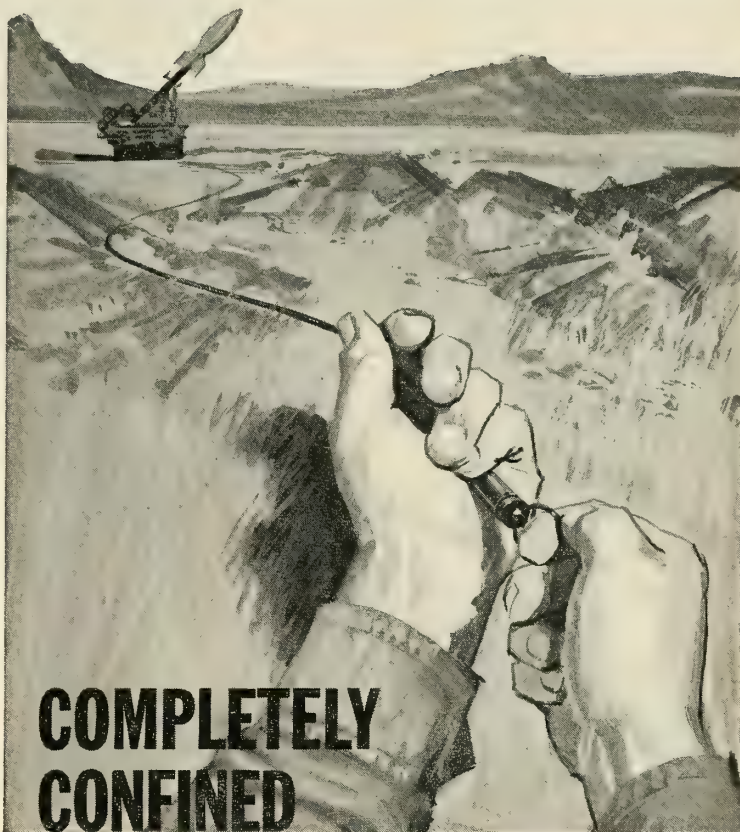
To the Editor:

While we agree with the basics of your editorial "On Booze, Blondes and Bashes" (M/R, Oct. 23), we are quite disturbed that Boeing is the only company mentioned specifically in the editorial. I am quite sure you would agree that we were perhaps the most innocent parties as regards "B, B & B" at Philadelphia. While your mention of Boeing was in connection with another matter, I am afraid that many people will connect us with the basic subject of your editorial.

We have always taken a very conservative view of shows and exhibits and in fact participate in fewer than practically any other company. You may recall that we were the only major company not represented at the World Congress of Flight

missiles and rockets, November 27, 1961

Ask your Du Pont Explosive Systems Specialist about:



**COMPLETELY  
CONFINED**

## MILD DETONATING FUSE

### Protection against RF energy

This new and unique ordnance device enables you to transmit a uniform, high-velocity detonation for unlimited distances—with essentially no risk of damage to adjacent components.

You can get Du Pont Completely Confined Mild Detonating Fuse (MDF) in a variety of explosive trains, encased in concentric sheaths of metal, plastic, and fiberglass. It is far more insensitive to physical shock and RF energy than conventional electric systems, but can be easily fired non-electrically.

The protective jacket shields it against stray electrical currents such as those emitted by radar, radio transmitters or other high energy generators. Thus, Completely Confined MDF protects against premature detonation.

Also, non-electrical firing does away with the need for a source of EMF, enabling you to save weight by eliminating batteries.

Now obtainable with a core load of 2 grains/ft. of either PETN or RDX and a detonation velocity of 6,500-7,000 meters/second, Completely Confined MDF offers you a fast, reliable impulse transmission medium.

A Du Pont Explosive Systems Specialist is available to help you with your ordnance design problems. Just write E. I. du Pont de Nemours & Co. (Inc.), 2446 Nemours Building, Wilmington 98, Delaware.



**WEAPON SYSTEMS  
SPECIALTIES**

BETTER THINGS FOR BETTER LIVING... THROUGH CHEMISTRY

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# SAY WHEN

This old phrase has acquired new meaning as the simple statement of a vital automatic control problem. Some means for timing inter-related operations (precisely, repetitively and reliably) is essential in a wide variety of advanced airborne and space equipments. Here is a new light-weight, high-reliability device to meet this need.



## REPEAT CYCLE TIMER by ELGIN MICRONICS

Already qualified for critical installations, the new Elgin Micronics Repeat Cycle Timer is now applied in many advanced systems. The unit, shown here approximately actual size, weighs only 6 ounces including mounting bracket (not shown) and is available for 400 CPS operation at 115 or 28 volts. Pre-set timing cycles may range from 30 seconds to 60 days. Additional data on performance, including detailed specifications and environmental ratings, will be furnished on request.

# ELGIN MICRONICS

division of Elgin National Watch Company 366 Bluff City Blvd., Elgin, Illinois

Plants in Elgin and Rolling Meadows, Illinois and Chatsworth, California

Represented nationally by Airsupply-Aero Engineering Company, a division of The Garrett Corporation

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## ... letters

in Las Vegas. My head is still bloody from that one, but I still believe we were right.

Carl M. Cleveland  
Director of Public Relations  
The Boeing Company  
Seattle

*We did not hesitate to mention Boeing's name because, as we can state from many years of experience, Boeing is known and respected throughout the industry as one of the most conservative firms in this regard.—Ed.*

### To the Editor:

We agree completely with the concluding paragraph in your editorial. There should be fewer meetings, better papers and less booze, and it would improve the industry image. But this is like being against crime and sin and in favor of motherhood. Everyone agrees.

You know there are good advertisements and good exhibits and even good editorials—just as there are bad ones. Using overdrawn examples as you have done is applying a tar brush to everyone.

We aren't complaining, either. We were just wondering what a "whacking sum" for a display is? And why was the Boeing display an "obviously" expensive one? (Your statistics are a little puzzling, too, but a current *Fortune* article has more to say on that subject.)

The survey by Clapp and Poliak was a fine, constructive piece of work. We in the exhibit industry welcome such efforts toward improvement. Let us have more of that kind of material. We, along with such reputable concerns as they are, will continue working to make our medium live up to its ability as the most effective and worthwhile selling tool available—as it has been for centuries, throughout the world.

Roger R. Tierney  
President  
Floats, Inc.  
El Monte, Calif.

### To the Editor:

Just read your editorial in Oct. 23rd issue on "On Booze, Blondes and Bashes" . . . Congratulations!

Here's one small voice crying in the wilderness that agrees wholeheartedly with you. I've "slept" through many papers. Just had to let you know there are other who feel the same way about the subject.

Daniel J. Walsh  
Press Relations  
General Precision, Inc.  
Tarrytown, N.Y.

### To the Editor:

The second and third reading of "On Booze, Blondes and Bashes" in your 23 October issue has convinced me that I want to circulate this to several people in our company who may not have seen it. If it isn't too much trouble please send me fifty reprints of that editorial and bill me for them.

E. S. Thompson  
Defense Field Operations Dept.  
General Electric Co.  
Los Angeles, Calif.

missiles and rockets, November 27, 1961



## names in the news—

**Dr. S. Dean Wanlass:** Elected president of Packard Bell Computer Corp. In addition to his new post, he will continue to serve as group vice president-Defense and Industrial Group of the parent Packard Bell Electronics Corp. Other new officers named by the board are **Kenneth R. Jackson**, vice president and director of administration; **William Seiden**, vice president and director of manufacturing; and **Theodore J. Smith**, vice president and director of marketing. **Lowell R. Day** continues as treasurer and **William H. Moore** as secretary.

**John F. Jacobs:** Named assistant vice president—Technical Operations for the Mitre Corp. He will share with the vice president of Technical Operations the responsibility for policy and the active technical management of Mitre's many system engineering programs. Prior to joining Mitre in 1958 Jacobs spent six years at MIT in various system engineering assignments in air defense work.

**Dr. David J. Mann:** Appointed director of research of the Reaction Motors Division, of Thiokol Chemical Corp., Denville, New Jersey. His new position includes responsibility for directing the total research effort of the division, including the development and synthesis of liquid and solid propellants.

**John B. Lawson:** Appointed director, administration and manufacturing at Ford Motor Company's Aeronutronic Division, Newport Beach, California. He will have overall responsibility for such functions as industrial relations, finance, public relations, manufacturing, facilities, purchasing and supporting services. Prior to joining Ford in 1949, Lawson was vice president of Ferracute Machine Co., and was business manager and controller of Villanova University.

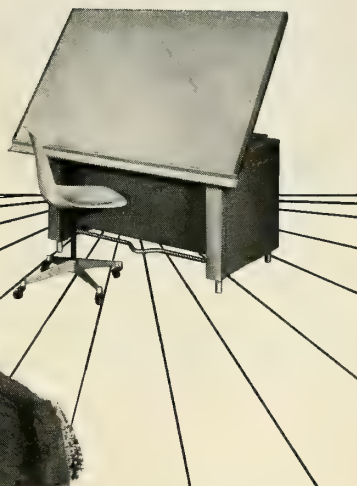
**Henry J. Fitzpatrick:** Appointed manager of contract administration for the Ford Division of Royal Industries, Inc., Pasadena, Calif. Fitzpatrick was formerly associated with the Garrett Corp.

**Sidney Minault:** Named vice president of manufacturing of Dunn Engineering Corp., Cambridge, Mass. He came to Dunn Engineering earlier this year from Northrop Corp. and was previously vice president and general manager of the National Research Corp.'s Equipment Division and vice president and general manager of Tracerlab, Inc.

**Dr. John G. Frayne:** Appointed manager of the Data Systems Department of the Marquardt Corporation's Pomona Electronics Division. In this capacity, he will be responsible for directing all activities relating to the design and development of data processing and display systems. Frayne has been engaged in the fields of electronics and physics for almost 40 years. Before accepting a position with Mar-



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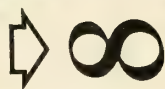
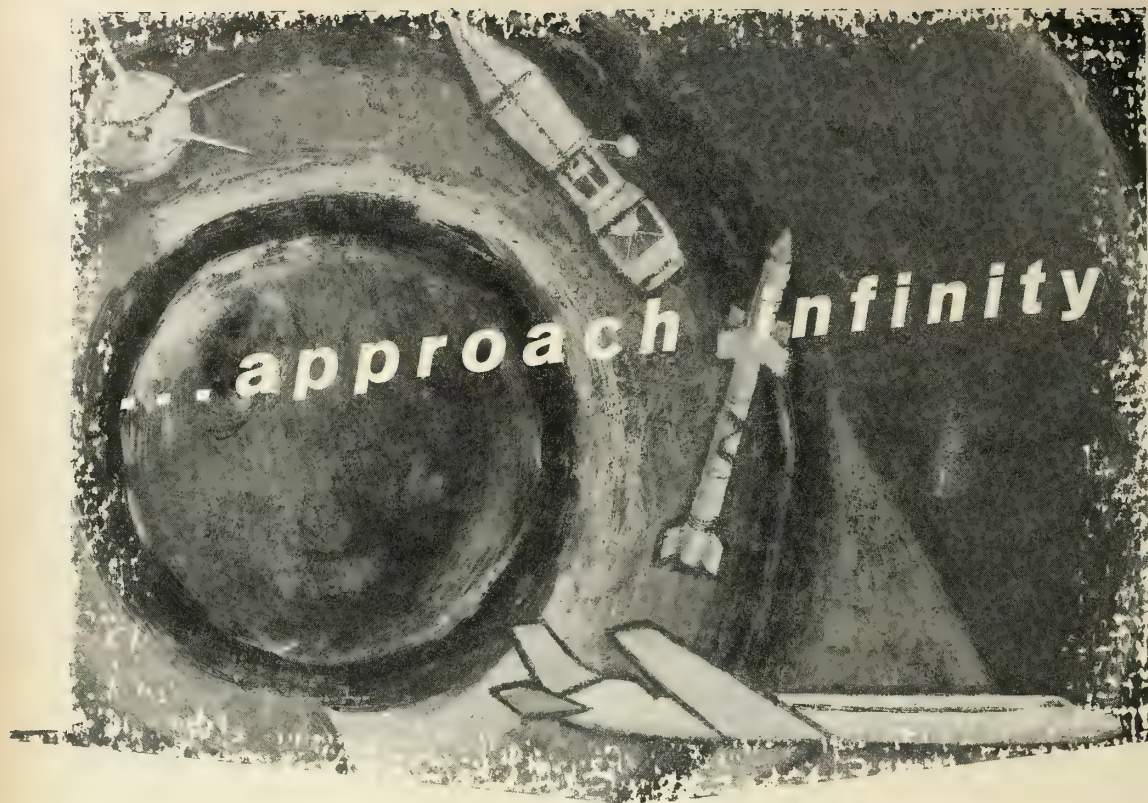
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hardt, he was the manager of the Electromechanical department of Datalab Division of Consolidated Electrodynamics Corp.

**R. C. Stiff:** Named Senior division manager of a new engineering operations division of the Liquid Rocket Plant of Aerojet-General Corp. Four divisions have been consolidated into the new division, with Stiff heading the set-up. He previously served as manager of the engineering and research division.

**Harry W. Burdett, Jr.:** Has joined American Machine & Foundry Company's Government Products Group as manager planning. Prior to his new position Burdett was with Thiokol Chemical Corporation's Reaction Motors division, Denile, N.J. for 16 years, where he worked on long-range technical planning and market research for the design of advanced liquid rocket systems for spacecraft and missiles.

**Dr. William T. Clary:** Named director systems research in the information systems department of North American Aviation's Space and Information Systems Division, Downey, Calif. Prior to joining North American he held managerial positions at Aeronutronic and Hughes Aircraft in the electronic systems and aerospace systems engineering and analysis areas.

**Alfred A. Blanco:** Appointed director marketing, plans and proposals, at Page Communications Engineers, Inc., a subsidiary of Northrop Corp. Blanco, who has been with Page since 1960, was previously associated with U.S. Army and U.S. Air Force electronic engineering agencies engaged in supervising engineering activities related to long range communications, radar and air navigation systems throughout the world.

**E. C. Carman:** Named to fill a newly created position, director of marketing, in Avco Corporation's Nashville, Tenn. Division. Carman has been with the company for 13 years in various positions. Prior to joining Avco, he was employed by Consolidated Aircraft Corp., Tucson, Arizona.

**Everett S. Glines:** Appointed general manager of Republic Aviation Corporation's Missile Systems Division. Glines,

who has been with Republic since 1944, has filled numerous executive engineering positions.

**Vaughn R. Chadbourne:** Elected president of Air Borne Controls, Sun Valley, Calif. He is a leader in the field of electrical design and will utilize his long experience in expanding the company's capabilities to keep step with its rapid growth. Chadbourne will also remain as chairman of the board of Electronic Sealing Inc. of Sun Valley.

**William I. Switzer:** Named vice president of Astrometrics, Inc., Santa Barbara, Calif. Backed by extensive experience with Arnoux Corp., North American Aviation and Chance Vought Aircraft, he joined Astrometrics in 1959.

**F. R. Zatlin:** Named director of program management at Ewen Knight Corporation, with the responsibility of over-all management of both contract programs and independent projects initiated by the company. He was formerly director of engineering and vice president of Johnson Electronics.

**Donald W. Chrisman:** Appointed director of planning for the Martin Electronic Systems and Products Division, Baltimore. He will be responsible for the division's operational and long-range planning. Chrisman has been with Martin since 1948. Previously, he was with the Farnsworth Television and Radio Corp. and has been with the Federal Bureau of Investigation.

**Norman F. Svendsen:** Appointed to the newly-created position of associate manager of the Support Systems Department, Engineering Mechanics Lab of Space Technology Laboratories, Inc. Svendsen, formerly head of the department's Launcher Systems Section, has been with STL for five years.

**Gustave A. Linenberger:** Named vice president and general manager of Aerojet-General Nucleonics, a subsidiary of Aerojet-General Corp. **Robert Gordon** was named vice president and technical director of the company. Linenberger has been with AGN since 1956, serving as associate technical director and assistant manager of engineering. Prior to joining AGN, he participated in early design and operation of Project ROVER experiments.

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### DECEMBER

**Annual International Visual Communication Congress**, cosponsored by Society of Reproduction Engineers, American Institute for Design and Drafting and the American Records Management Association, Biltmore Hotel, Los Angeles, Dec. 2-5.

**National Aerospace Support and Operations Meeting**, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Fla., Dec. 4-6.

**19th Annual Electric Furnace Conference**, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.

**Eastern Joint Computer Conference**, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C., Dec. 12-14.

**Annual Meeting, American Association for Advancement of Science**, Denver, Dec. 26-31.

**Annual Meeting, American Statistical Association**, Roosevelt Hotel, New York City, Dec. 27-30.

### JANUARY

**8th National Symposium on Reliability and Quality Control**, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

**National Plant Engineering and Maintenance Show and Conference**, Convention Hall, Philadelphia, Jan. 22-25.

**Solid Propellant Rocket Conference**, ARS, Baylor University, Waco, Tex., Jan. 24-25.

### FEBRUARY

**Western Electronic Week and Pacific Electronic Trade Show**, Las Vegas and Los Angeles, Feb. 3-11.

**Winter Convention on Military Electronics**, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

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Ebert-Anlage 3



# contracts

## AIR FORCE

\$380,000—Thiokol Chemical Corp., Bristol, Pa. for stage 1 engines and related equipment for *Minuteman* ICBM.

\$725,000—General Dynamics Corp. for *Atlas* missile trainers and for continuation of design, development and fabrication of the *Centaur* booster. (2 contracts)

\$649,440—General Electric Co., West Lynn, Mass. for missile trajectory measurement system.

\$68,000—American Bosch Arma Corp., Garden City, N.Y. for *Atlas* missile guidance sets.

\$123,330—Avco Corp., Wilmington, Del. for development, fabrication and test of decoys for the *Nike-Zeus* target support program.

\$900,000—Aerojet General for additional work on the *Minuteman* engine.

\$200,000—Douglas Aircraft Co., Santa Monica, Calif. for production of ground equipment for *Skybolt* missile.

\$7,000—Thompson Ramo Wooldridge, Los Angeles, for electronic equipment to be used in a system to assist in making command decisions.

\$90,000—Cohu Electronics, Inc., San Diego, Kin Tel Division, for closed-circuit television systems for the *Titan* ICBM.

\$9,255—B. D. Collins and Charles Fletcher, Lompoc, Calif. for modification of 75-1 complex pad No. 1 at Vandenberg AFB.

\$9,996—Cornell Aeronautical Lab., Inc., Buffalo, for continuation of research studies of high-temperature phenomena in hypersonic flows.

\$7,585—Technical Operations, Inc., Washington Research Office, D.C., for study to determine preliminary estimates of the

data flow and machine requirements for processing Project *VELA* uniform data.

\$35,640—Stanford University, Calif., for continuation of studies in hypersonic flow theory.

\$33,694—Adcole Corp., Cambridge, Mass., for design, construction and testing of portion of payload for *Nike-Cajun* type rocket.

## ARMY

\$4,542,226—Bendix Systems Div., Ann Arbor, Mich., for *Advent* satellite communication system modification.

\$2,712,401—Raytheon Co., Lexington, Mass., for marine concurrent repair parts, *Hawk* missile system. (3 contracts).

\$818,000—Fairchild Stratos Corp., Hagerstown, Md., for long range drone surveillance system.

\$197,000—Raytheon Co., Missile and Space Div., Bedford, Mass., for study of radar echo characteristics.

\$133,000—General Instrument Corp., Thermo-electric Div., Newark, N.J., for R&D to result in the fabrication of one experimental model and three development models, including manufacturers drawings and final technical report, of thermoelectric generators.

\$93,829—Texas A&M Research Foundation, College Station, Tex., research for the continuation of work on the basic contract for improving, evaluating and extending the capabilities of a model of a meteorological simulator.

## NAVY

\$1,500,000—Sperry Gyroscope Co., Syosset, Long Island, N.Y. for support and training equipment and services in connection

with navigation subsystems for ballistic missile submarines.

\$709,000—Edward R. Marden Corp., Brookline, Mass. for additional *Polaris* navigation and fire control system overhaul, Portsmouth Naval Shipyard, N.H.

\$266,000—B. F. Goodrich Aerospace and Defense Products, Akron, Ohio for production of solid fuel motors for the *Loki* atmospheric sounding rocket.

## MISCELLANEOUS

\$2,800,000—Hughes Aircraft Co., Culver City, Calif. from Raytheon Co. for work on ARPAT.

\$2,400,000—Avco Corp., Lycoming Division, Stratford, Conn., from Thiokol Chemical Corp. for rocket motor cases for the *Dynasoar* Program.

\$1,500,000—Beckman Instruments, Inc. from North American Aviation for electronic units to be used in the *Minuteman* check-out system.

\$1,000,000—Gulton Industries Inc., Metuchen, N.J. from Martin Co. for instruments and systems for the *Titan II* ICBM program.

\$839,845—ITT Communications Systems, Inc., Paramus, N.J. from the Defense Communications Agency for preparation of a simulation model of the Defense Communications System.

\$600,000—Consolidated Electrodynamics Corp., from Hughes Aircraft Co., for development of miniature, seven-channel tape recorders for the seven *Surveyor* spacecraft.

\$405,651—Pacific Semiconductors, Inc., Hawthorne, Calif. from North American Aviation for silicon diodes for use in the inertial guidance system of the *Minuteman* ICBM.

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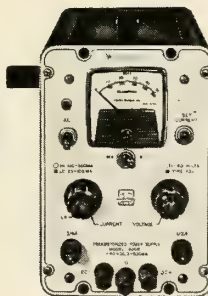
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# Hardware?

Maybe connectors were "hardware" twenty years ago.

That's when the P-38 was the hottest fighter plane we had. Pilots were proud when they could hit 300 MPH and go up to 50 or 60 thousand feet. With this kind of performance requirement, most connectors worked without a hitch. You just connected them and forgot about them, like nuts and bolts.

## HOW TIMES HAVE CHANGED

Now we're up around Mach 5 and altitude has been pushed into outer space. Nose cones light up like giant soldering irons and components have to operate in a near vacuum.

Fortunately, Amphenol engineers saw that the old "hardware" concept was headed out the window. Programs coming up were going to need connectors that could put up with terrific environmental conditions of heat and altitude cycling. For example, at high temperatures most of the elastomers used as insert materials or connector seals either melt into a puddle, turn into a cinder, or set-up and lose compression.

What's more, connectors now have to keep on functioning *all* the time, with no allowance for failure. So—Amphenol designers went to work developing a connector to meet the new space-age standards.

## DISSECTING MOLECULES

The Amphenol Materials Lab, with the help of a shiny new infra-red photospectrometer, began dissecting elastomer molecules. They were able

to pinpoint the weak spots in molecular structure where breakdowns begin. Then they were able to plan and build new molecules, with built-in "armor" to protect against failure. Result: an exclusive silicone rubber compound that maintains its integrity and elasticity under severe temperature extremes and also withstands exposure to violent new propellants like hydrazine and nitrogen tetroxide.

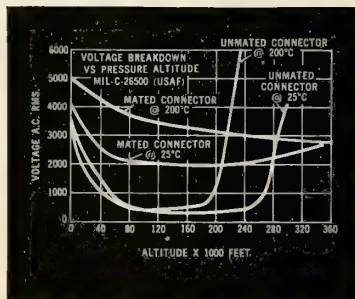
At the same time, Amphenol design engineers were hard at work perfecting metal-to-metal shouldering of mating shells that allowed precision control over compression of the sealing ring. In addition, the metal-to-metal design damped vibrational stress nine times more effectively than resilient damping. Finally, they incorporated a semi-rigid anti-deflection disc to control insert expansion under thermal stress.

Having all the pieces, we put them together, called it the Amphenol 48 Series, and started testing. In the vacu-

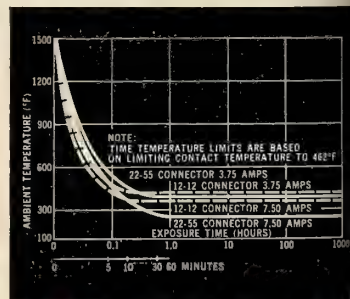
um chamber, 48 Series connectors operate very nicely at a simulated altitude of 500,000 feet. They are quite comfortable in the hot box at 200°C ambient, *carrying full rated current*. They don't even mind going up to 600°C, if they don't have to stay too long. In short, Amphenol 48's can take almost anything you throw at them.

## PROJECTS WANTED

Amphenol designers have established criteria for determining connector time-temperature-current capability. This information will be especially valuable to engineers presently engaged in "exotic" projects, perhaps the kind of project where previous connectors have failed to measure up to the new space-age standards. If this is the case, contact an Amphenol sales engineer. He's a "space-age hardware" expert. Or, write directly to Bob Dorrell, Vice President, Engineering, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



High altitude air has low dielectric strength. By maintaining an air-tight seal 48 Series Connectors enjoy extremely high voltage safety factors.



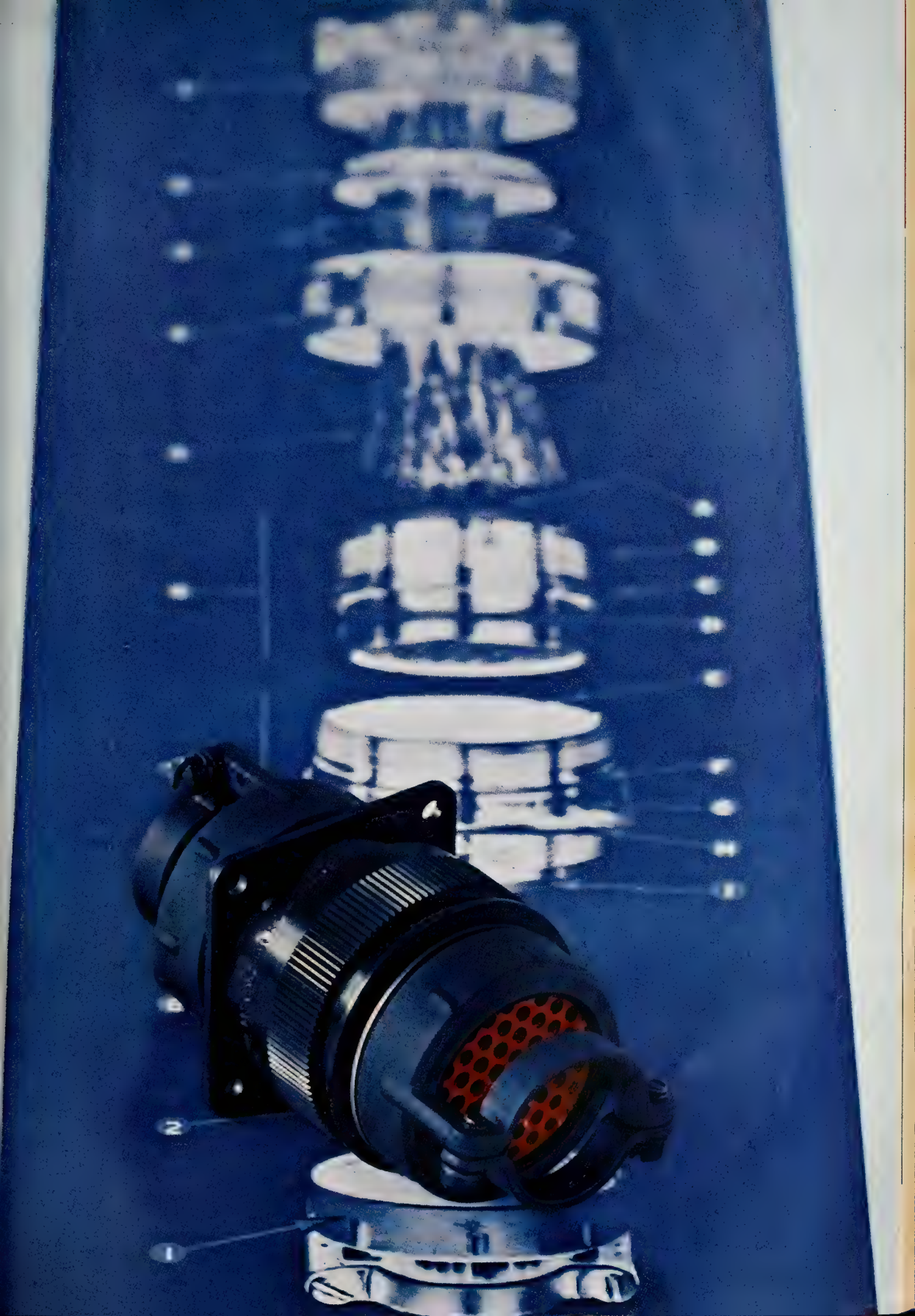
While Amphenol 48 Series Connectors are nominally rated at 200°C, they can also withstand considerably higher short-time temperature exposures.

Amphenol 48 Series Meets Mil C 26500 (USAF)

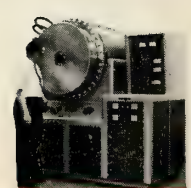


**Connector Division** / Amphenol-Borg Electronics Corporation





11-10-64 2/3 T1



## IT'LL NEVER GET OFF THE GROUND

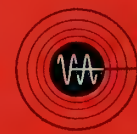
Fortunately, Varian's VacIon® pump systems don't *have* to get off the ground to simulate hyper-altitude conditions. This makes life a good deal easier for scientists who choose to study outer space without becoming a part of it.

"Packaged" vacuums can be provided for suitcase-size chambers or giant rooms containing complete missiles. Republic Aircraft's new space chamber will use a 5,000-litre/second VacIon pump system. Convair and NASA are already operating VacIon pumps in hyper-altitude experiments.

Any scientist with his feet on the ground can get 150 miles of altitude from a Varian electronic pump system. Write *Vacuum Division*.



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NOVEMBER 20, 1961

# missiles and rockets

THE MISSILE SPACE WEEKLY



600-mile Polaris Leaves Observation Island

Polaris A-2 Nears Production Line . . . . .

Re-entry Heat May Far Exceed Estimates .

At Least 10 Apollos Will Be Built . . . . .

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Nike Hercules, Nike Zeus, Minuteman, Pershing, N.A.S.A. Programs, Scout and Little Joe.

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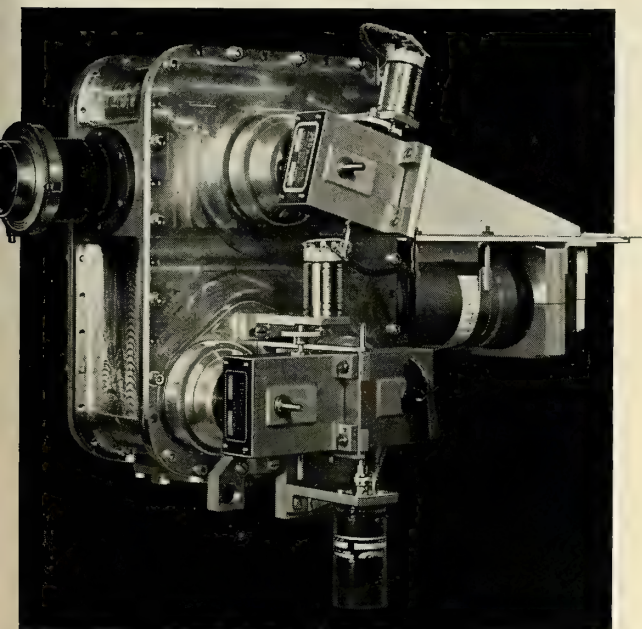
Above: Actual  
Photograph of  
Grand Central  
Rocket Co's.  
ten-foot diameter  
BIG BOOSTER.

Below: Ten inch diameter  
RETRO-ROCKET.  
Both are in current  
manufacture at  
EXCELCO.



# PHOTO-DIELECTRIC TAPE CAMERA SYSTEM

... a major advance in  
space image-sensing



The development of photo-dielectric tape permits the design of a totally new image-sensing system for utilization in satellites and space vehicles. A prototype camera for use with this tape has already been operated and tested. This system, one of the first developed primarily for use in space, offers a number of advantages over existing photographic and television techniques.

Operating on the principle of storing an optical image by converting it to an electronic charge pattern, the photo-dielectric system has inherently high resolution since the picture charge pattern is read out directly as a video signal by an electron beam. Moreover, it offers real promise of providing response in various parts of the radiation spectrum in addition to the visible including infrared and ultraviolet with sensitivity better than standard photographic techniques.

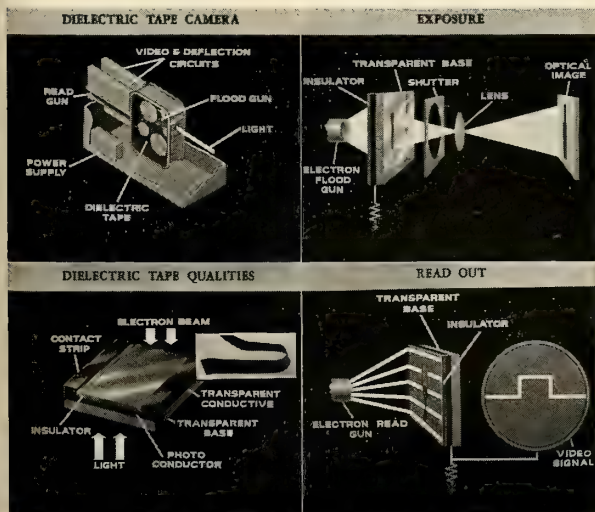
Readout is accomplished by use of a finely focused electron beam which scans the charge pattern. It is then converted directly to a video signal for transmission to the ground. Readout can be accomplished at different speeds to compensate for various power and band-width requirements dictated by the nature of the space mission.

The flexibility of the system permits readout of the same image numerous times, if desired, by ground control. In the laboratory, the same image has been read out up to 100 times without serious degradation of quality. Yet, the image is erased completely, with no trace of "sticking," as the tape is flooded with electrons prior to exposure. Transistorization of the package results in minimum weight and low power requirements.

Since a high vacuum is essential to the operation of a photo-dielectric tape camera system, it is "at home" in the harsh environment of space. Also, dielectric tape is virtually unaffected by radiation thereby eliminating this hazard to ordinary photographic film. It is also reusable and serves as its own storage medium for remote picture-taking sequences.

To find out how RCA's new photo-dielectric tape camera developments can fill your requirements for space image-sensing systems, write to the Manager, Marketing, Astro-Electronics Division, Defense Electronic Products, Radio Corporation of America, Princeton, New Jersey.

And for a challenging, rewarding career in electro-optical systems development, apply to the Employment Manager, RCA Space Center, Princeton, New Jersey. All qualified candidates are considered regardless of race, creed, color or national origin.



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*Opportunities for:*

# Aerospace Vehicles Engineers

The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

## Structures

**Senior Dynamicist.** Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

**Loads Analyst.** To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

**Reliability Analyst.** To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

**Stress Analyst.** To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

**Design.** Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environ-

ment and hand vacuum, plus a background in materials is desired.

## Heat Transfer

**Space Vehicle Heat Transfer.** Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

**Aerothermodynamicist.** Experience in hypersonic real gas dynamics, heat transfer, ablation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

## Equipment Installation

**Packaging and Installation Engineer.** To perform optimum packaging and installation design for missile and/or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

## Controls

**Optical Devices.** Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

**System Test.** To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

**Control System Analysis.** Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

**Circuit Design and Development.** Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

---

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler**, Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 44, California.

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SPACE SYSTEMS DIVISION



# missiles and rockets

Volume 9, Number 21

November 20, 1961

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## THE COVER

Complete systems integration test of Polaris A-2 from Observation Island. The 1500-nautical-mile-range strategic missile is nearing production. See p. 12.



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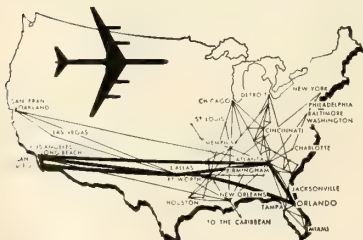
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## letters

### Technical Meetings

To the Editor:

My heartiest congratulations on your Oct. 23 editorial ("On Booze, Blondes and Bashes").

This is a real service to the industry.

T. Roland Berner  
President and Chairman  
Curtiss-Wright Corporation  
Wood-Ridge, N.J.

To the Editor:

Some of us who wrestle periodically with the problems of industrial exhibits read your editorial with great interest, even delight.

Our Chef d'exhibition, Joe Waters, has circulated the editorial with some cogent comment out of his deep experience in this field, which I will send to you if it makes the circuit and comes back to my desk.

Joe, like myself, was pleased that you wrote the piece because it exposed to public view some of the problems that have turned Our Man Waters from a smiling, good-natured and helpful young man into an embittered cynic who I suspect is on the verge of breakdown or alcoholism. He insists, and I believe him, that he would not have time or energy to enjoy either the booze or the blondes at these industrial bashes—which may well save him from the aforementioned fate.

I would like to think that your editorial will stop or at least slow the onward rush of industrial exhibition, but I am afraid nothing short of the 50-megaton force can accomplish the miracle.

However, like I said, we enjoyed the reading.

Bert W. Holloway  
Corporate Director  
Advertising, Publicity, Promotion  
Lockheed Aircraft Corp.  
Burbank, Calif.

To the Editor:

Congratulations on your editorial!

As a former Prom-Trotter, I couldn't agree more.

As taxpayers, we both know the underlying reason such blasts can be conducted. The costs go into cost-reimbursable contracts, and come out with the 7% fee as profit. I think this is far worse than the so-called "propaganda advertising" evil, or imagined evil, which has resulted in the recent DOD restrictions on recovery of costs through advertising.

In fact, it can hardly be put in the same class, for the publications which carry the advertising are both instructive and educational . . . and cannot reasonably exist without the advertising revenue.

As a former participant in these combined exhibit-orgies, I had a helluva good time at Company (and Government) expense. However, when assuming the job of controlling my Company's participation, I shut the whole thing down, save for the

sending of one employee to each meeting. He went with a purpose . . . to meet customers, to discuss with them requirements. You'd be surprised how many of our military customers have congratulated us on our activity!

Last year we took a poll of ten officers sitting at our Company tables (\$25 per head, plus wives). It was very interesting to find out that only three of the officers would even venture to try and remember the various Company Hostesses they had had during the past year at such functions as AFA, AUSA, NRC, ASNE, AOA, ARS, EIA, AFCEA, Navy Relief, Navy Day Dinners, Forrestal Dinners, IAS . . . oh hell, you name them. One with a 100% and the others expressing varying degrees of being fed up with the whole nauseating mess. These ladies got tired of being entertained by strangers who mean nothing to them, whom they will never see again, and who have extended the invitation (let us face it) because the host wants something from her husband.

And, as you say, the papers are full of speeches . . . Ugh!

Actually, industry-government get-togethers on a quasi-social plane are potentially valuable. Unfortunately, as you point out, we have turned these things into a combination of a floating cocktail party, three-ring circus, Roman Orgy, and a ostentatious show of how much we can get back from Uncle Sam. CPFF.

P.S. If you use this, please omit the name. I'm selling too much to the sinner.

To the Editor:

Congratulations on a fine editorial.

You have expressed the thoughts of lot of people out here who plowed plenty of effort and money back there.

We, too, hope it was worth while.

Don Fairchild  
Public Relations Manager  
Ryan Electronics  
San Diego, Calif.

To the Editor:

Just read your editorial and want to add a hearty amen.

My duties here at S & M include keeping abreast of electronic developments, as well as the election and purchasing components and hardware for our K Division.

Recently I attended the National Electronics Conference here in Chicago and my experience was very similar to what you describe at the other events. I talk to engineers and purchasing agents who had traveled hundreds of miles to attend the show, and they commented along the same line.

The displays were beautiful and were the models. But try and get the information you need and it is almost impossible.

The bigger corporations seem to have dozens of so-called sales engineers or sales managers who have a stock anst to any question:



"Sorry, but I don't know the price. I can't tell you about application either, because that product is handled by another division. Their office is down the hall from mine, and I can't keep up with everything the firm makes. . ."

You see a new electronic instrument that you might be able to buy, and no one in the booth can give you any idea at all about whether it costs \$75 or \$500. If you ask for a ball park price, all you get is a blank look.

You fill in the idiot cards and carefully check the boxes relating to items you are interested in, and three weeks later the mail comes, and it is literature about some other, unrelated product.

Then, when you finally find the item you want and start to deal with the firm, you may have to work your way through half a dozen specialized reps, sales engineers, and desk men until you finally get in touch with Joe the Janitor, who really knows something about the product. When you finally reach him, you get some service.

We buy only a few select items, but our experience is typical, God help the designers and project men who have to buy the stuff for our defense projects.

Congratulations on your editorial stand. Here's hoping the clods and loafers don't get together and scalp you. They are pretty well organized and like things pulled up. That way, management can't really know whether they are doing a good job or not. You have to go to a convention to see how bad it really is.

Bill McHugh  
Electronics Editor  
Science and Mechanics  
Chicago

## Stressing Quality

To the Editor:

Allan Aircraft Supply Company would like permission to quote parts of the June 16 M/R editorial entitled "A New Emphasis on Quality."

As a major manufacturer of AN and MS fittings, which are used extensively in the missile industry, we feel that our customers should be appraised of the heavy emphasis on greater quality control and long-life performance of hardware. . . .

Arnold Wayne  
General Sales Manager  
Allan Aircraft Supply Co.  
North Hollywood, Calif.

Permission granted.—Ed.

## Practical Suggestion

To the Editor:

Referring to *Explorer VII*, the headline of a recent article attracted my attention: "NASA Wishes Chattering Satellite Would Shut Up."

It seems to me that here is a wonderful opportunity to practice the "rendezvous" so often talked about.

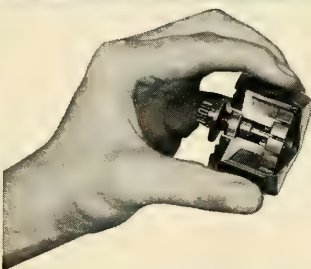
A close shot would prove feasibility, and a direct hit ought to make NASA doubly happy by having shut up our chatterbox."

Henry W. Schloten  
Hagerstown, Md.

missiles and rockets, November 20, 1961



# LEAR MAGNETIC POWDER CLUTCHES



## PROVED ON SERGEANT AND OTHER HIGH PERFORMANCE MISSILE AND AIRCRAFT

The powder clutch is not new — but the performance and reliability of the LEAR magnetic powder clutch is a break-through in the state-of-the-art.

Its use in high response servo systems can solve many problems currently experienced in systems using electric motors or hydraulics or pneumatics.

- LEAR patented magnetic powder mixtures are totally dry — no leaking, no packing, greater proportional shear strength
- RELIABILITY — units have operated more than 50 million cycles without deterioration or failure
- HIGH RESPONSE — meets the stringent requirements of most advanced servo applications
- AVAILABILITY — a range of sizes from 5 inch-ounces to 2500 inch-pounds are available now.

Write for catalog of complete line which includes installation and application information. Ask for GR-324.



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## *Thought*

### *How many never think . . . Taylor*

An atmosphere of creativity is as much a part of the facilities of Guided Missiles Range Division as the funds and equipment necessary to carry out the programs assigned.

Now with emphasis on new explorations, the need is for technically respected people with leadership ability.

New career positions are available on the technical staffs of the Planning, Engineering and Operations Departments. Requirements are for physicists, engineers and mathematicians with B.S., M.S., and Ph.D. degrees.

A career with GMRD may well provide the career opportunity for you. Address your inquiry in confidence to: Professional Employment Manager, Guided Missiles Range Division, PAN AMERICAN WORLD AIRWAYS, INC., Dept. V-44, P. O. Box 4336, MU 113, Patrick Air Force Base, Florida. Inquiries will receive prompt replies and all qualified applicants will be considered for employment without regard to race, creed, color or national origin.



GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA



# The Countdown

## WASHINGTON

### ing On the Apollo Carrot

In the hot in-fighting for the *Apollo* spacecraft prime contract, **COUNTDOWN** hears that one of the principal competitors is spreading some extra special icing on its proposal. The "sweetener": An offer to build the spacecraft in any state in the union that NASA, or the Administration, desires. The offer is understood to be aimed at both NASA's wish to broaden the technological base of the Manned Lunar Landing Program—and the Administration's commitment to put more work in high unemployment areas.

### Minuteman: The Crucial Test

The first successful launching of a *Minuteman* from an operational-type silo at Cape Canaveral is expected to be the beginning of a greatly augmented series of test launchings over the next six months. The first attempt at conducting a hot *Minuteman* launching from a silo ended in failure earlier this year when the second stage prematurely ignited seconds after the missile cleared the silo's top.

### Dyna-Soar: Reasons behind the Knife

The principal Defense Department reasons for refusing to release the extra \$86 million appropriated by Congress for *Dyna-Soar* are technical—and budgetary. DOD officials contend that Air Force and contractor claims of gains to be achieved by the accelerated program involved too much technical risk. They also felt the \$86 million was a good place to cut rising spending in FY '62.

### Ranger Again at the Cape

*Ranger II* is scheduled to be launched from Cape Canaveral within the next 10 days. Previously, the checkout flight of the lunar exploration capsule was postponed twice. *Ranger III*, which will be rough-landed on the moon, is still scheduled to be launched in the first quarter of 1962.

### Zeus Again at Pt. Mugu

The Army is expected to try another two-stage launching of the Western Electric *Nike-Zeus* within the next several weeks from Pt. Mugu, Calif. If successful, the Army will then probably switch quickly to the first three-stage firings down the Pacific Missile Range.

### The Effect of Rendezvous

One of the most significant results of a decision to put more emphasis on orbital rendezvous—rather than direct assault—in sending the first *Apollo* spacecraft to the moon is in the development of military space weapons. The early development and perfection of rendezvous techniques is considered to be an absolute necessity for maintaining or wresting control of near space.

missiles and rockets, November 20, 1961

## Astronaut Glenn Goes First

Marine Major John H. Glenn, 40, is understood to have been tapped secretly by NASA to be the first American to attempt to orbit the earth in a *Mercury* capsule. More slippage (see p. 15) now appears to have definitely put the flight off to February or March.

## INDUSTRY

### Saturn S-1 Award Imminent

The award by NASA of the huge production contract on the *Saturn S-1* booster is expected within the next week or so. Seven companies—Chrysler, Boeing, Ling-Temco-Vought, Ford Aeronutronic, Northrop and Lockheed—are battling for the contract that could run eventually to between \$1 billion and \$2 billion. The *S-1* clusters of eight North American *H-1* engines will be produced at NASA's Michoud Arsenal plant in Louisiana.

### On the Prowl for Suppliers

NASA's Marshall Space Flight Center is labeling as a canard charges that it has an "in-grown" procurement policy of dealing with old-line suppliers. Officials are claiming that, on the contrary, they are spending a great deal of effort on turning up new sources and that orders are now going mostly to new suppliers.

### Front Office

At Minneapolis-Honeywell James H. Binger, 45, is moving up to the presidency, succeeding Paul B. Wishart, who becomes board chairman . . . Dr. S. Dean Wanlass is the new president of Packard Bell Computer Corp.

### Swedish Army Shopping

The Swedish Army is considering early procurement of two or three new missiles. Swedish officials have been looking at the Convair *Redeye* and *Mauler* and the English Electric *Blue Water* and other missile systems in similar classes.

## INTERNATIONAL

### New Range in Europe

One of the first projects planned by the newly organized European Space Research Organization is the establishment of a new European missile range for launching sounding rockets. The most likely site is considered to be at Kiruna in northern Sweden.

### New Pad in Australia

The *Blue Streak* launching pad under construction at the Woomera Missile Range for the West European Space Program is reported to be within three months of completion. Current plans call for Australia to manage the launching site and range. British and French technicians will handle the launchings themselves. Australia is contributing the use of the range to the program, but no Australian funds are expected to be put into the program yet.

# The Missile/Space Week

## Shots of the Week: Transit, Discoverer Go Successfully

The Navy stepped up its drive for an operational navigation satellite system with the launch Nov. 15 of *Transit IV-B*. The 200-lb. beacon satellite, powered like the still-orbiting *IV-A* with a modified *SNAP-3*, went aloft piggy-back with a new *TRAAC* (Transit Research and Attitude Control) satellite also weighing 200 lbs. The two were to separate at a 550-mi. altitude—*TRAAC* to test the feasibility of using the earth's gravitational field to stabilize a satellite so that it maintains the same face toward the earth.

*Discoverer XXXV* also shot into orbit Nov. 15, carrying special telemetry designed to trace the cause of malfunctions which have prevented recovery of recent capsules. The latest 1700-lb. *Discoverer* was to eject a 300-lb. capsule in about four days after launch.

In other tests:

- A NASA *BIOS I* biomed payload was lost after a Nov. 15 firing into space from Point Arguello, Calif. (see below.)

- The Air Force failed in another biomed experiment Nov. 10 when it

had to blow up an *Atlas D* carrying a squirrel monkey and other specimens 15 sec. after launch.

- Air Force Maj. Robert White piloted the *X-15* rocket plane to a record 4093 mph Nov. 9. The plane's windshield cracked during the Mach 6 flight at 95,800 ft. No further speed trials are planned, but NASA says the *X-15* will try soon for a maximum altitude flight of about 250,000 ft.

## Possible Strategy Shift Seen In Soviet Shipbuilding Plans

The Russian Navy may be switching its shipbuilding program to meet the threat of *Polaris* submarines.

The authoritative "Jane's Fighting Ships" in its latest edition reports that the Russians are pushing the construction of speedy missile destroyers and frigates and cutting back on submarine construction.

If this is correct, U. S. strategists believe the Soviet move is an attempt to build up its ASW capabilities in the face of the growing *Polaris* fleet.

Meantime, Vice Adm. John Thatch, senior U. S. ASW officer in the Pacific, says the Navy is "hunting today's quarry with yesterday's equipment"—contending billions are

needed to check the Soviet-Chinese sub threat.

## New Contract Awards

More Air Force money went this week into first-stage *Minuteman* rocket engines through a \$15.4-million contract to Thiokol Chemical Corp. Work on the engines will be carried on at Brigham City, Utah.

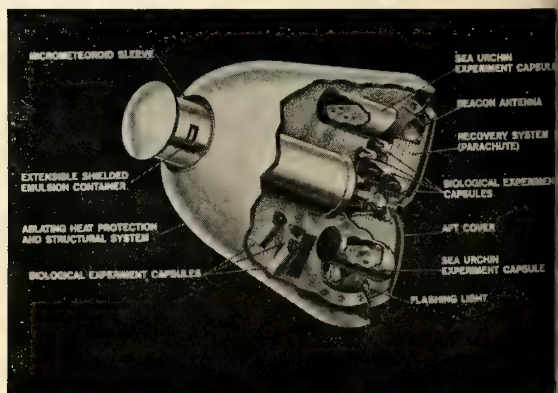
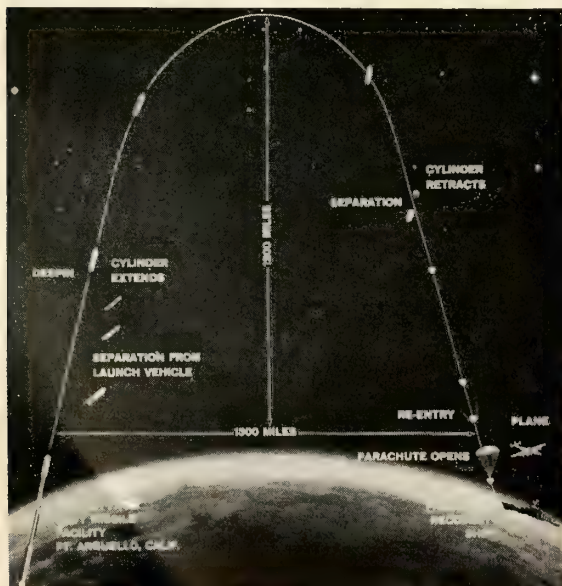
The Air Force also moved to increase its defense alarm system by awarding a \$8.4 million contract to Mitre Corp. of Bedford, Mass. The advanced command and control systems will supply instant warning to defense leaders in the event of surprise attack at key installations.

Other DOD awards went to General Electric at Syracuse (\$3.6 million) for production of a missile trajectory measurement system; American Bosch Arma Corp. (\$3 million) for *Atlas* inertial guidance equipment and MIT (\$2.7 million) for development of additional airborne guidance systems.

## Frustration on the Moor

Labor disputes are still hobbling construction of the third and final

## Second BIOS launch attempt pressed forward . . .



A QUICK BACK-UP shot was being readied by NASA last week for a BIOS I flying biology lab probe that went astray Nov. 15. The capsule, carried by an Argo D-8 rocket, landed far from Navy recovery teams. Officials hoped to get another shot off within a few days from Pt. Arguello. In the capsule are 17 experiments to improve man's survival chances in space. Devices will measure radiation, acceleration, and zero-gravity effects on cell structures. (M/R, Nov. 13, p. 15).



BMEWS site, being built in England.

Weekly walkouts, primarily by steel erectors, over bonuses and working conditions have set back completion of the ICBM early warning installation several months.

Unfinished steelwork is holding up installation of electronics gear.

The British government is planning to hire additional workers to maintain original completion schedules. There are presently about 700 workers at the Fylingdales Moor construction site. This force will be increased to about 1000.

The BMEWS stations at Thule, Greenland, and Clear, Alaska, are now operational.

### Unified Spares Buying Nears

Procurement of electrical and electronic spares for all three armed services will soon come under the control of the newly created Defense Supply Agency.

Top logistics officers in the services see advantages in catalog standardization and total inventory reduction; other officials are somewhat wary of the placement of still another agency at the head of an already complex chain of command.

The DSA, which will take over 12 existing supply and service organizations early in 1962, also will be authorized to recommend new supply facilities to DOD. DSA will also have administrative responsibility over the Defense Coordinated Procurement Program, Federal Catalog Program, Defense Standardization Program, Defense Material Utilization Program, and the Defense Surplus Personal Property Disposal Program.

### LOD Adds Offices

NASA's Launch Operations Directorate at Cape Canaveral is setting up its own financial and procurement office.

The latter office will have a staff of 20 and will be located in Cape Canaveral, Fla. Gerard Michaud will be its director.

The office will perform procurement services in the upcoming expansion at Cape Canaveral, both for LOD and for other NASA field center activities there.

The office will begin operation January 1, 1962. The financial office will have a staff of 19 under the direction of Louis Melton.

### AF Sharpens Buying Tools

The Air Force is embarking on a new campaign to up-date its procurement methods with development of a "two-step" bid technique.

The first step, according to Lt. Gen. M. E. Bradley, Deputy Chief of Staff for Systems and Logistics, involves submission of technical proposals without cost figures. After analysis of the proposals, the companies submit cost figures. The result, says Bradley, "is sharper competition."

In an article in the AIA publication *Aerospace*, the general points out the need for review of AF procurement techniques and creation of advanced methods for handling future needs. For this purpose, the AF has established a Procurement Policy Development Branch, staffed by persons whose job "is to think, and to get the help of industry in this thinking—to the end that we have up-to-date, realistic procurement policies."

The new branch is under the control of the Directorate of Procurement Management, headed by Maj. Gen. W. T. Thurman.

### New Boom for Titanium

Titanium manufacturers in this country are anticipating this year's total shipment of the versatile metal to be the largest since the 1957 boom. Some observers feel that volume may exceed the 11,315,820 pounds shipped in 1957.

Primary reason for the renewed interest in titanium is the introduction of new alloys aimed at space-age application. The bottom fell out of the market in late 1957 following a government shift from manned aircraft to missiles. Titanium, because of its light weight (approximately one-half that of steel), anti-corrosive properties, strength, and rigidity, was especially suited to manned aircraft applications.

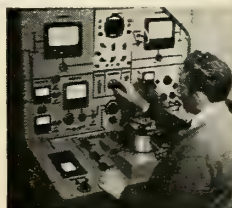
Shipments of titanium fell to slightly over 5 million pounds in 1958. However, through gradual new application to missile/space usage, total volume has once more begun to rise steadily, reaching over 10 million pounds in 1960.



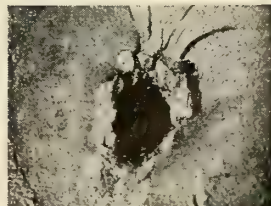
Very High  
Production Standards



Rigorous  
Quality  
Control



Firing Accuracy



**SS.10 SS.11**

Anti tank missiles  
designed and manufactured by

**NORDAVIATION**

2 a 18, RUE BÉRANGER CHATILLON s/m BAGNEUX SEINE - TEL. ALESIA 57-40



# Polaris A-2 Production Starts

**First operational A-2's will be on station sometime in the spring, substantially increasing striking range; Air Force presses ahead on its strategic missiles**

**by James Baar**

THE *POLARIS A-2* missile is entering early production, all but ensuring a dramatic increase in the strategic flexibility of the *Polaris* submarine fleet by mid-1962.

The first production models of the *A-2* 1500-nautical-mile missile are expected to begin undergoing flight tests from Cape Canaveral early next year.

Operational models of the *A-2* are expected to be first deployed about June, probably aboard the nuclear-powered Submarine Thomas A. Edison or in a mixed load of *A-1*'s and *A-2*'s aboard the Sam Houston.

Meantime, here is how the other advanced programs for U.S. strategic missiles stand:

- *Atlas*—All 13 squadrons of *Atlas* are still expected to be deployed by the end of next year. An *Atlas F*, third of the *Atlas* models being deployed, is expected to be elevated and launched from a hardened silo later this year or early in 1962 from Vandenberg AFB, Calif. Schilling AFB, Kan., will be the first of the 12-missile *Atlas F* squadrons to become operational. To date a total of 100 *Atlases* have been launched. The box score: 66 successes, 21 partial successes, 13 failures.

- *Titan*—The first *Titan II* is expected to be launched early next year from Cape Canaveral. Meantime, op-

erational *Titan I*'s are waiting for installation and check out at *Titan* bases. The first nine-missile *Titan I* squadron at Lowry AFB, Colo., is expected to be operational by Jan. 1. The original date was last summer. Work was delayed primarily by strikes. All 12 *Titan* squadrons—I and II—are expected to be operational before the end of 1963. To date 44 *Titans* have been launched. The box score: 32 successes, 8 partial successes, 4 failures.

- *Minuteman*—Testing of *Minutemen* over the next six months is expected to increase greatly. The first squadron of 50 *Minutemen* at Malmstrom AFB, Mont., is expected to be operational by the end of 1962, but the first *Minutemen* probably will not be operational by June as previously scheduled. More R&D money for the mobile *Minuteman* still is expected to be included in the FY '63 budget, ending the one-year stretchout of the mobile program. To date four *Minutemen* have been launched. The box score: two successes, one partial success, one failure.

- *Skybolt*—The first hot launching of a *Skybolt* is expected to take place in February. A B-52 flying out of Eglin AFB, Fla., will launch the solid-fueled missile. Inert *Skybolts* already have been air-dropped from B-52's. The missiles also are reported to have been dropped from an RAF Vulcan bomber.

- *MRBM*—Pentagon plans to de-

velop a 1000-mile-range, highly mobile, highly accurate, highly versatile missile for deployment on land or sea are extremely tentative. The Air Force has received the assignment to plan the R&D program. But to date no funds are available for contracts—and none probably will be made available before FY '63. One key factor is whether any of the NATO countries for whom the *MRBM* would be primarily developed would be willing to buy it.

The final major milestones for the *A-2* test models were the integrated system launching from the surface test ship Observation Island last spring and an underwater integrated system launching from a nuclear-powered submarine within recent weeks.

The launching from the Observation Island took place off the coast of Florida March 9. It was described as a complete success.

An *A-2* test missile was successfully launched in secrecy from the *Polaris* Submarine Ethan Allen Oct. 23 while the submarine was submerged on the Atlantic Missile Range. Another was successfully launched Nov. 8.

In all, 18 *A-2*'s have been launched including the two from the Ethan Allen and six from the Observation Island. The total box score: 14 successes, 3 partials, 3 failures.

- *Meaningful*—The deployment of the *A-2* is of considerable significance



in that it will increase either the already high survivability or the destructive power of *Polaris* missiles.

The 300-nautical-mile extension in the range of *Polaris* missiles means that *Polaris* submarines will have thousands of additional square miles in which to hide—and still remain in striking distance of their targets in the Soviet Union.

The extension also means that almost no area in the Soviet interior will be beyond the striking range of a sea-launched missile.

And, finally, it means that if the additional power of the *A-2* is not used to achieve greater range it can be used to carry a large nuclear warhead.

• **Where they'll go**—The deployment of *A-2* will not be conducted immediately throughout the *Polaris* fleet.

The George Washington Class submarines—five in all—have launching tubes that are too short to take the *A-2*, which is about 30 inches longer than the *A-1*. Therefore, the George Washington Class submarines will continue to carry the *A-1* until they return to the United States for overhaul in about two years.

The Ethan Allen is the first of the *Polaris* submarines with longer launching tubes designed to take both the *A-2* and the 2500-mile *A-3* that is due to be operational in mid-1964. The Sam Houston is the second of the Ethan Allen Class, the Thomas A. Edison the third.

The Ethan Allen, scheduled for deployment early next year, will still be too early to go to sea with anything but *A-1*'s. But the Sam Houston, scheduled for deployment in the spring, may carry a mixed load. If not, the Thomas A. Edison is certain to deploy about June with a mixed load or all *A-2*'s in her tubes. All *A-1*'s will be replaced with *A-2*'s as soon as they become available.

The John Marshall, the only other *Polaris* submarine scheduled to be deployed in 1962, will go to sea in late summer or early fall with *A-2*'s for its first war patrol.

In all, the United States by next September or October will have a total of nine *Polaris* submarines operational. Five will be carrying the old *A-1*'s; four will be carrying the new *A-2*'s.

• **Half-year hiatus**—At this point, there will be approximately a half-year break in the deployment of *Polaris* submarines. The Thomas Jefferson is expected to be deployed in the late spring of 1963.

After the Thomas Jefferson there will be another pause until late summer, when the Lafayette, first of the third class of *Polaris* submarines, is expected to go on station. Two months

later the Alexander Hamilton will be deployed. And, finally, through the 29th submarine the ships will begin moving into the fleet at a rate of one a month.

The reason for the sharp breaks between the 9th and 11th submarines is the withholding by the Eisenhower Administration for one year of congressionally-approved funds for *Polaris* sub construction.

The possibility of a similar break in deployment in the mid-60's is now developing under the Kennedy Administration.

Vice Adm. William Raborn, director of the *Polaris* program, told Congress flatly earlier this year that unless long-lead-time items are procured for additional submarines beyond the 29th in FY '62, there will be a month-by-month gap when the submarines are authorized. The gap began to open last month.

However, there have been indications that the gap will not be allowed to grow too large.

The Administration is understood to be considering the inclusion of a request for about six more *Polaris* submarines in the FY '63 budget. If this is done, the Administration also is expected to

authorize the Navy to begin procuring the long-lead-time items—mostly reactor parts—immediately.

The addition of six submarines would bring the total fleet to 35, nearly four nine-ship squadrons. At least one of these, probably the third, is expected to be deployed in the Pacific. The second is expected to be deployed at least in part in the Mediterranean.

As with the first, the later squadrons will operate from an advance mobile base centered around a *Polaris* tender. The second tender, the Hunley, was launched earlier this year. The third tender also is under construction.

• **Eye on Pacific**—All Atlantic-based squadrons will be supplied with missiles from the *Polaris* Weapons Annex near Charleston, S.C. No firm decision has been made to date on where the *Polaris* Weapons Annex for the Pacific will be located—despite previous statements that it would be in Hawaii.

However, there appears to be no question that there will be a Pacific squadron—particularly now that the *A-2* is nearly operational. The Pacific offers too many attractive "stations" for *Polaris* submarines. ❧



MAP SHOWS flexibility provided by 1500-mile-range *Polaris*, as compared with the 1200-mile version. Deployment of the 1500-mile missile would leave virtually "no place to hide" within the Communist bloc from the U.S. Navy's sea-launched weapon.

by 2-1/2 times or more . . .

## Re-entry Heat May Far Exceed Earlier Estimates

NEW STUDIES indicate the re-entry heat barrier facing lunar and other non-orbital missions will be at least two and a half times as severe as previous estimates.

This information may have already affected NASA's *Apollo* lunar spacecraft design—and could account for apparent delays in arriving at a final configuration.

The theoretical work by Dr. S. M. Scala of General Electric's Missile and Space Vehicle Department indicates that partial ionization of air at re-entry speeds up to 37,000 fps (25,000 mph) between 100,000 to 240,000 ft. altitude is a greater factor in convective heating than currently assumed.

Scala's study, sponsored by NASA, included the contribution of ions and

electrons as well as molecules and atoms in producing vehicle heating. His work showed that while ionization has little effect on vehicle heating up to orbital speeds, it accounts for a dramatic rise in heat transfer as the vehicle approaches escape velocities—36,000 fps and above.

Previous theories had considered convective heating of a dissociated gas but had not taken into sufficient account the effects of a partially ionized gas.

Scala's theories were confirmed through independent experiments conducted by Dr. W. R. Warren in a newly-developed GE hypervelocity shock tube tunnel.

The instrument uses an electrically heated helium gas piston to drive air past a model at speeds and heats similar

to those encountered by a vehicle returning to earth from deep space.

The test period is extremely short—between 20 and 30 microseconds—but this is long enough to run a steady-state experiment measuring the rate of heat transfer from air to model at energy levels some three times higher than obtained in other existing shock tubes.

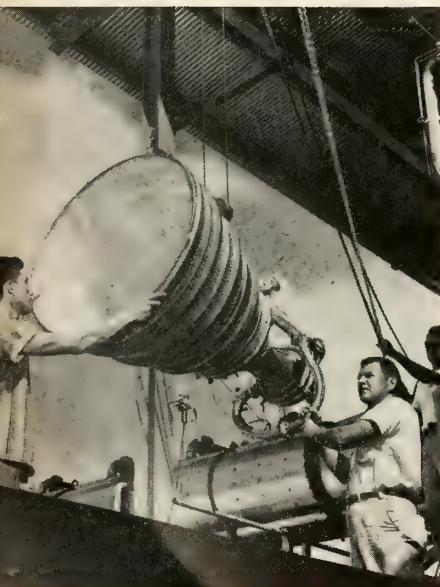
• **Close simulation**—One important aspect of Warren's work is the use of air. The air in the shock tube can be given properties that would be found in air at any specified altitude and speed.

In the tests, Warren simulated altitudes between 50,000 and 100,000 ft., and speeds up to 40,000 fps. The air in the shock tube is accelerated and given its high heat energy by the electrically heated helium piston gas.

Helium is sealed off at one end of an 11-ft. tube by a diaphragm. Vaporization of a tungsten wire suspended horizontally through the helium provides a uniform electric arc, instantly imparting a tremendous jolt of energy along its horizontal plane.

The helium bursts the diaphragm transferring its heat and speed to the air which flows past a model at the far end of the tube. About 70% of the electrical energy used is converted to thermal energy.

While both theoretical and experimental work was devoted to convective heating, studies are in progress on radiative heating to see if these effects differ from the transfer rates indicated by current radiative theories.



THRUST CHAMBER of RL-10 is lifted to firing stand at P&W Florida Center.

## First Liquid Hydrogen Engine Passes Test

THE U.S. LAUNCH vehicle program got a boost last week when the nation's first liquid hydrogen rocket engine successfully completed its preliminary flight rating test.

The engine—the RL-10 designed and developed by the Pratt and Whitney Division of United Aircraft Corp.—will be used to power the Centaur space vehicle and the S-IV second stage of the Saturn C-1 super booster.

The successful tests will do nothing to speed up the Centaur development, however. Originally scheduled for flight-testing late this year, other problems—including its tankage system, have forced a postponement of its first launch until sometime next year.

NASA officials said that the test marks a significant milestone in the development of the engine which produces a specific impulse 30% greater than current rocket engines using conventional hydrocarbon fuels

such as kerosene. This makes possible greater payloads or longer range for launch vehicles.

The test, consisting of 20 captive firings, was completed in five days. All firings were accomplished with the engine under simulated space conditions. Throughout the test, the engine consistently produced its rated 15,000 lbs. thrust.

NASA officials said that inspection after the test showed that the engine was still in condition for continued firings and further testing.

Development of the RL-10 was started in October, 1958. During its development program, the engine has completed over 700 firings for an accumulated firing time of 60,000 seconds.

Pratt & Whitney has delivered a total of 12 engines to NASA and the Douglas Aircraft Corp. for testing prior to the launching of the Centaur and Saturn vehicles which will use it.



# NASA to Order At Least Ten Apollos

**Manned flight boss Holmes' estimate is rated conservative for \$5-10-billion program**

by Hal Taylor

AT LEAST 10 *Apollo* spacecraft will be ordered under the prime systems contract for the manned lunar vehicle coming up for award next month.

NASA, moreover, will expect the contracting team to produce a prototype or model of the three-man spacecraft 9 to 12 months after the go-ahead.

These and other new details of the quickening *Apollo* effort were disclosed this week by D. Brainerd Holmes, who came aboard Nov. 1 as director of NASA's Office of Manned Space Flight—the headquarters management agency for *Apollo*.

Holmes was interviewed by *Missiles and Rockets* as:

—NASA postponed the orbital flight of a chimpanzee until next month, thereby killing off chances for a manned orbital flight this year and forcing slippage in planned 1962 *Mercury* flights.

—The Air Force had to blow up an *Atlas* carrying a small squirrel monkey in a biomed experiment Nov. 10. The missile—an *Atlas D* which is used in the *Mercury* program—veered off course 15 sec. after launch.

• **Conservative figure**—While Holmes would only estimate that at least 10 *Apollo* spacecraft will be built, it is quite likely that the final program will call for the use of quite a few more. Various NASA officials have estimated the cost of the total spacecraft program at from \$5 billion to over \$10 billion.

In other major comments, Holmes said that:

—The *Apollo* will have four major modules—command, service, orbiting laboratory and a lunar landing propulsion unit. The orbiting laboratory will not be part of the manned lunar landing mission, but will be used for scientific experiments in earth and lunar orbital flights.

—Even though NASA's new organizational setup gives the field center directors the right of appeal to Associate Administrator Dr. Robert C. Seamans, Jr., "I expect to run the program. If I'm not given the needed authority, it just won't work." He added that he expects little second-guessing from the

field centers.

—He is sticking to the official timetable which calls for a U.S. manned lunar landing by the end of the decade, but hopes that it can be done quicker. An estimate by NASA officials that use of the "orbital rendezvous" mode of space travel can cut two years off the schedule remains to be proved.

• **Buildup**—Holmes said that his office of Manned Space Flight will ultimately have a staff of 500 persons. He expects to have 250 on board by June 30, 1962, the remainder added by the end of Fiscal 1963.

A little more than 200 of the positions will be in the systems engineering office to be headed by Nicholas E. Golovin.

That office, he said, will be broken down into Mission Operating Analysis and other groups. MOA will look at the whole plan and approach to the manned lunar landing, including the launch vehicle to be used and whether "orbital rendezvous" or direct flight is the better method.

The other segments of the office—which Holmes says will play the major role in his management setup—include a reliability analysis section, orbital operations engineering, and systems integration.

Holmes feels that the deliberations of this group will not delay the *Apollo* program. If there is such delay, he contends, some new or better approaches will be found.

The remainder of his 500-man group will be split up about equally between the Office of Launch Vehicles and Propulsion, Aerospace Medicine, Spacecraft and Flight Missions and Program Review and Resources Management.

Space agency officials blamed a leak in the hydrogen peroxide line in the *Mercury* spacecraft's in-flight attitude control system for the postponement of the launching of *MA-5*. The flight had been tentatively scheduled for Nov. 14 as the last rehearsal before the first U.S. manned orbital flight attempt.

The same sort of leak has turned up in other *Mercury* flights and has caused

similar delays in the past. In order to repair it, officials removed the capsule from its perch atop the *Atlas* booster. NASA officials said at least two weeks would be needed to make repairs and that the delay might be longer.

When the repairs are completed, the *Mercury* capsule with its medium-sized chimpanzee passenger will be hurled into an orbit 100 to 150 miles high. The capsule will circle the earth in a flight expected to last about 4½ hours. Then, on a command from the ground, it is to return to earth in the Atlantic Ocean some 1000 miles from its Cape Canaveral launch site.

The primary purpose of the flight will be to test the functioning of the capsule, particularly its environmental control system. This will provide oxygen to sustain the astronaut in a trip through the vacuum of space. It will also be the first orbital test of the advanced type of *Mercury* capsule with a "picture" window and an explosive escape hatch.

Primary reason for inclusion of the monkey is to make a "living" checkoff of the capsule environmental control system. The monkey will be in a pressure-tight plastic and metal box. This will be connected to the system in the same manner as the astronaut's space suit.

The shot with the "chimp" will mark the first time the U.S. has attempted to put an animal into orbit. Russia accomplished the same feat almost four years ago when it orbited the dog Laika in *Sputnik II*.

In the Air Force shot, the small monkey—called "Goliath"—was enclosed in a one-ft.-by-one-ft. cylinder located near the base of the 12-ft.-tall nose cone on the *Atlas* booster.

The *Atlas* was intended to fly a 5000-mile course, hurling the nose cone to an altitude of 650 miles. Scientists hoped to learn how Goliath withstood the stresses of space flight, especially the approximately 20 minutes of weightlessness he would have to endure on the 25-minute flight. Although only 6 inches tall, the animal had brain and body characteristics similar to man's. ❧

# Many Channels Make ComSat Economic

by Charles D. LaFond

BOSTON—The great potential of a communications satellite system is its promise of a large increase in the data-handling capacity of transoceanic communications.

On a per channel basis, satellites—even with the most pessimistic assumptions—will cost less than submarine cables for any but short links, if the number of channels is large. However, even with the most optimistic assumptions, a satellite communications system will scarcely be competitive with microwave relays for conventional overland uses.

These conclusions by two scientists from the RAND Corp. were presented here before the 14th Northeast Electronics Research Engineering Meeting 1961 (NEREM-61).

In a paper on economic aspects of communications satellites, S. H. Reiger and W. H. Meckling said two points must be considered: first, the overall costs of such a system; second, the prospects for utilizing a vast increase in transoceanic capacity, provided the system cost is reasonable.

Total cost is based on R&D, initial installation, and operating expenses. Also, the authors point out, only a part of R&D costs is directly associated with communications equipment development. A large portion of R&D expenditures would be for launch-vehicle procurement for orbital testing.

Initial costs for installation include all ground stations and placement of enough satellites in orbit to provide both desired channel capacity and continuity of service.

In addition to operation and maintenance of ground terminals, operating costs cover satellite replacements upon failure.

The authors reduced these cost considerations to a single equation permitting the parametric study of system cost behavior without using specific dollar figures.

To underline the need for a satellite system for transoceanic communications, Reiger and Meckling noted the growth history of overseas traffic, which has tripled in the last decade. They see no indications that the trend will change—in fact they predict an even faster growth rate if message charges are sub-

stantially reduced.

• **Third biggest show**—Upwards of 15,000 persons from the U.S. and abroad gathered last week to make NEREM-61 the third largest electronics meeting of the year.

Only the annual IRE convention and exhibition in New York and San Francisco's WESCON show surpassed this event in attendance.

The meeting was jointly sponsored by the Boston, Connecticut and Western Massachusetts sections of the Institute of Radio Engineers.

Keynote speaker was John L. Burns, president of Radio Corporation of America, who expressed concern over steadily rising costs in the nation's R&D programs, and suggested that the same management techniques that have so effectively increased efficiency in other business segments be applied to this problem area.

A 10% increase in the efficiency of the U.S. engineering effort, Burns asserted, would in effect add 70,000 engineers to our productive force.

• **Medium-orbit satellites**—For two-way telephony, the advantages of a medium-height, randomly located, active satellite system were presented in a paper by J. L. Glaser, of Bell Telephone Laboratories, Inc.

Placed in nominal orbits in the 2500-8000-nautical-mile range, such satellites would not be maintained in precise positions with respect to each other. Thus, said Glaser, there would be no need for on-board propulsion, which has a controlling effect on the service life of station-keeping satellites.

In addition, the Bell scientist stressed that transmission delay for the height range considered could offer far less degradation than that of a stationary system at 19,300 n. mi.

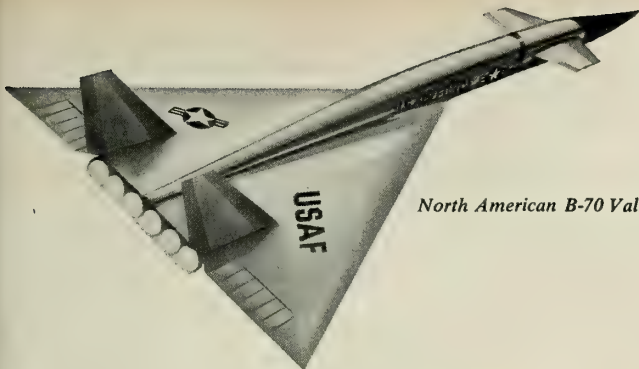
Instead, the system would employ a multiplicity of orbiting stations capable of serving the communications needs between many surface points. Individual vehicles might be visible to a given pair of ground terminals for only a small part of the time, Glaser said, but with a reasonable number of satellites the fraction of time in which at least one satellite was not visible would be inconsequential. Such occurrences would be predictable days in advance, and could be obviated by minor changes in traffic-handling procedures.



## Scope of Army's Missile Arsenal

*BIG AND SMALL solid-fueled missiles—A motor of the Army's Nike-Hercules surface-to-air missile dwarfs the shoulder-fired LAW antitank weapon. The LAW is now moving into the late stage of research and development.*





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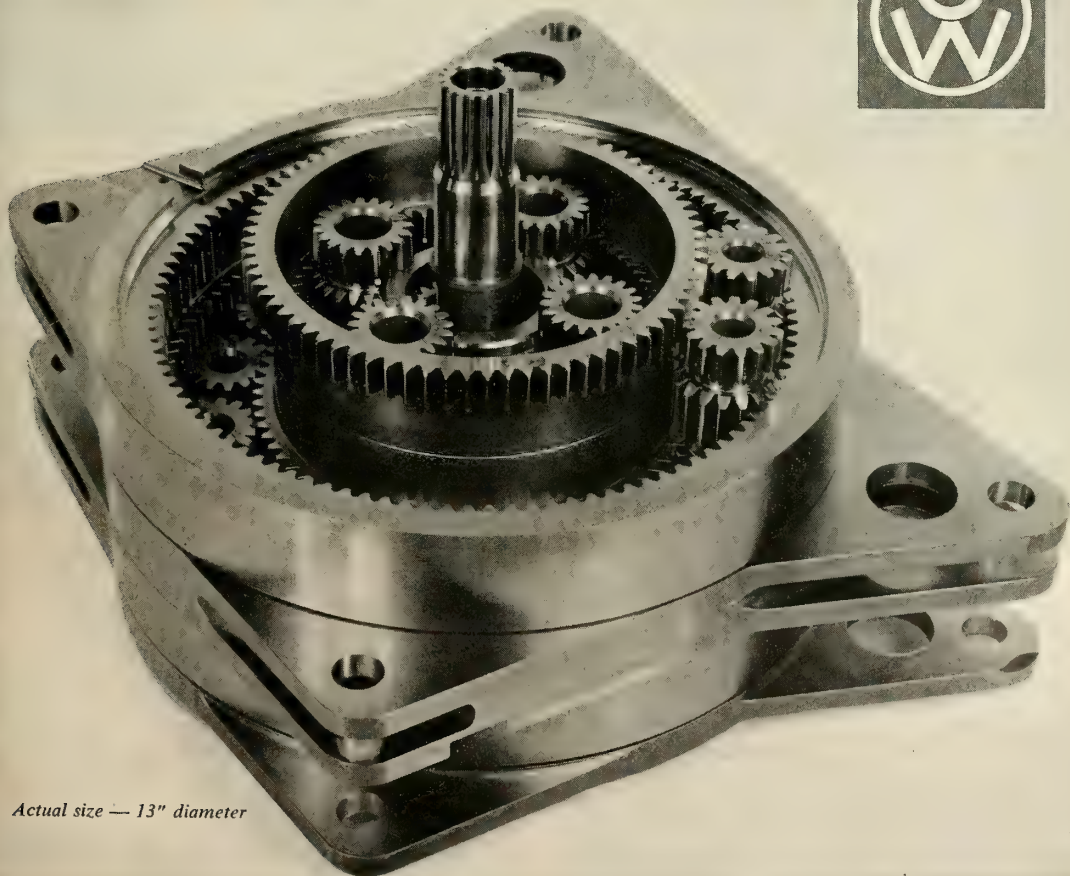
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## Objective: duplicate the cycle of life so man can sustain himself in space indefinitely

To leave the earth at all, man must take his environment with him. But no spaceship could hold all the air, food and water he'll need for any extended trip. His meager supplies will have to be constantly purified and renewed. There can be no waste. Every drop of moisture, every smidgeon of food must be reprocessed and reused.

This means that some substitute will have to be found for the fundamental cycle of life on earth. Northrop's Bioastronautics Laboratory is even now developing new strains of algae as a basic food source. They are investi-

gating biological means of reclaiming waste and purifying air. Studying the effects of hard radiation on living matter unscreened by earth's atmosphere. Learning more about how life is affected by the absence of gravity. Coming to grips with all the interrelated problems of life support.

When men finally move out to occupy space, Northrop's foresight in research will have helped to make their long-term survival possible.

# **NORTHROP**



# Technical Countdown

## ELECTRONICS

### Intensive Fatigue Studies Under Way

Using analog-digital computation techniques, Boeing is intensively studying fatigue problems of SAC missile carriers. Investigations concern the increasing missile loads in aircraft as related to runway and taxiway roughness. Boeing claims the program has already made it possible for engineers to predict whether or not a *Hound Dog*-packing B-52 can operate from specific runways, and what loads are likely to be encountered in particular portions of the aircraft.

### PMR Fleet Grows

A seventh missile/space vehicle tracking ship was delivered last week to the Pacific Missile Range. Newest of the range fleet is the 455-ft. USNS Range Tracker (T-AGM-1), formerly the Skidmore Victory, which will be based at Port Hueneme, Calif. It joins USNS Range Recoverer, Huntsville, Watertown, and Richfield at Hueneme. The other two vessels, USNS Longview and Sunnyvale, are based at Honolulu.

### Computer Switching Speed Increased

Switching rates to  $1-9$  second have been obtained with a new magnetic thin-film sandwich, IBM reports. The 5-layer computer memory components also switch 10 times faster than a single-layer equivalent circuit at the same driving current. Engineers say the real advantage of the device is that speed is obtained without loss of adequate output signal. Switching speed was measured using the Kerr magneto-optic effect; detection was made with a photomultiplier tube.

### Lear Guidance Studied by Army

A 500-ft. CEP (circular error probability) can be provided over a 30-mile range by using Lear's 30-lb. guidance system in tactical missiles. Being studied now for possible use in artillery-type Army missiles, the new system uses three gas-driven gyros for direct platform stabilization and eliminates almost all of the usual electronics used in such systems. After initial run up to 60,000 rpm, the package can produce a stable reference for 3-5 minutes—long enough to stabilize a 100-mile-range missile. The platform provides unlimited pitch-axis freedom,  $30^\circ$  in roll and yaw axes.

### Data Retrieval Solution Proposed

A super library employing a vast computer complex has been proposed by Belfour Engineering Co. to the Air Force as a practical means for solving the technical/scientific information retrieval problem. In a comprehensive report exploring means for developing a materials-information-processing capability, Belfour suggests use of a system to sift descriptive and empirical data and provide only primary information within minutes. Fill-in or background data chores would not be handled. The system would use a multi-dimensional matrix displaying all current materials data sources, ranged against materials types.

## ASTRONAUTICS

### Space Power Needs Outlined

Photovoltaic cells, primary batteries and static converters and inverters will fulfill spacecraft power needs until about 1965, according to the chief of JPL's Guidance and

Control Division. Beyond this time, however, a continuous, unregulated power capability of 2.5 kw. will be required. Photovoltaic cells, it is felt, will be too costly. Most likely candidates for future power systems seem to be solar or nuclear powered thermionic or turbine generators.

### Erectable Structures Requirement Specified

There is a real need for lightweight, erectable structures, a NASA official says, particularly for spacecraft parabolic antennas, solar panels, radiators, instrumentation booms and auxiliary drag devices. Especially pressing is the need for parabolic antennas up to 30 ft. in diameter, with surface deviations of less than  $\frac{1}{4}$  in. and space radiators with operating lifetimes of three years.

### Apollo Recovery Looks to Rogallo Wing

One of the requirements for the *Apollo* spacecraft—NASA's manned lunar landing program—is that it be adaptable to the Rogallo wing. Although it is presently planned to recover the manned spacecraft by parachute after re-entry, NASA officials are impressed with the potential of the batwing recovery technique and have specified its use if tests prove its value. Evaluation of the concept is being conducted at Edwards AFB—NASA's Flight Research Center.

## ADVANCED MATERIALS

### Glass-Wound Structures Gaining on Steel

While calling steel and other high-strength alloys "indispensable," a Defense Metals Information Center report categorizes the potential for improvement in glass fiber as "probably greater than for steel". *Minuteman* and *Polaris* cases were made out of commercial glass fibers, but an improvement in the Type E grade glass should lead to a "missile grade" material. The report also pointed to the possibility of considerable improvement in property consistency.

### Copper- and Silver-Infiltrate Tungsten

Fully sintered, controlled-density tungsten bodies infiltrated with copper or silver are being produced in quantity by Firth Sterling Inc. Billets having closely controlled densities varying from 65 to 83% theoretical are subsequently infiltrated to a minimum of 95% total density. Machining is easy and the infiltrant can be removed afterwards to provide a free-standing 99.9%-plus pure tungsten part.

### Saturn Bonding Fixture at Douglas

A 73-ton bonding fixture has been installed at Douglas-Santa Monica to bond plastic honeycomb insulation between aluminum alloy sections. These sections form the common bulkhead in the *Saturn S-IV* stage which separates the liquid hydrogen and liquid oxygen tanks. The entire bulkhead section is bonded in one step.

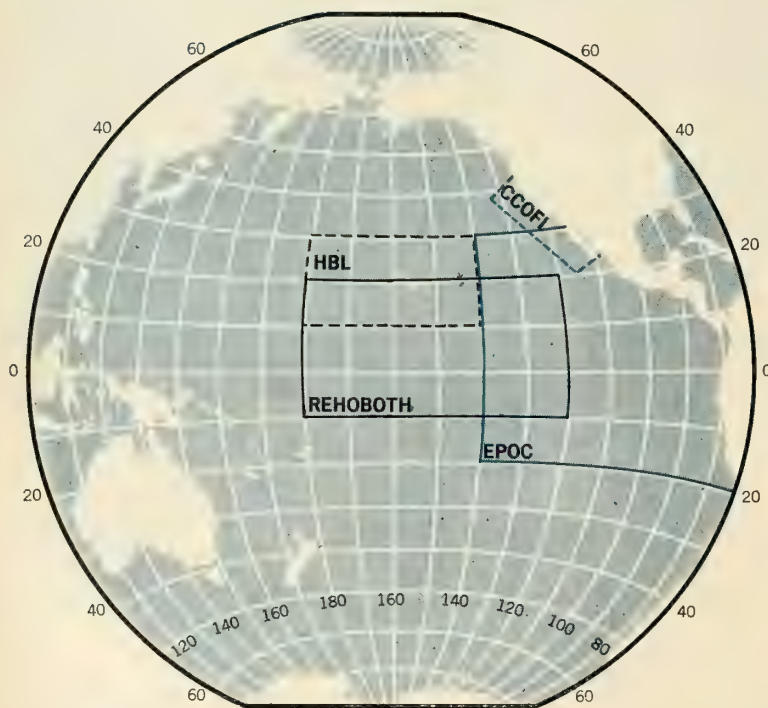
### Silicone Plant On-Stream

A \$1-million process plant for producing new types of intermediate silicone chemicals is in operation at GE's Silicone Products Dept. The facility is part of an expansion program involving nearly \$5 million in buildings and equipment. The complex turns out a range of silicone products for high-temperature applications.

# NODC Eager for Advice from Industry

***Oceanographic Data Center will supply companies with free processing and equipment-design information; agency wants help in planning its 'modular' data system***

by William Beller



**MAGNITUDE** of oceanographic data-handling problems in several areas of proposed and continuing oceanographic surveys (CCOFI, REHOBOTH, HBL and EPOC).

TO AVOID being drowned by an expected flood of oceanographic data, the newly formed National Oceanographic Data Center (NODC) is seeking industry help for what is expected to be a multimillion-dollar systems-and-instrument-development program.

NODC's purpose is to accumulate, process and retrieve oceanographic data from whatever scientific source it comes. Dedicated this past January and headed by Dr. Woodrow C. Jacobs, former Library of Congress science specialist, the Center is seeking to introduce large-scale machine processing techniques to oceanographic data-handling.

NODC also expects to play a major part in the research and development of new instruments that will yield data compatible with the Center's function.

"We are vitally interested in talking with anybody who wants to help us get organized," Jacobs told *MISSILES AND ROCKETS*. "Right now, we need industry advice on whole system development, from data collecting through reduction and utilization."

• **Industry's stake in NODC**—In the overall work of the Center, industry is directly involved in two ways:

1) Where industry is getting first-hand oceanographic data, the Center will take the information and reduce it. In this way, everybody benefits: the Center gets the data and industry gets some free processing.

2) NODC will give industry the oceanographic data it needs to design its own equipment. This equipment might be for navigational or oceanographic instruments, or for shoreline or off-shore facilities.

Jacobs describes the Center as "the middle-man between equipment designers and data surveys on the one hand, and the operational and research interests on the other."

The Center operates on an unclassified basis, opening its facilities to any legitimate inquirer. Though the data are unclassified, some of their arrangements are classified—and are used to support the ASW effort.

NODC is unique because it is an



interagency agency. Unlike the National Weather Records Center, which looks to the Weather Bureau for money and guidance, NODC reports to a Board of Directors which forms policy and contributes to the Center's upkeep.

On the Board are the Navy, represented by the Hydrographic Office (which also administers NODC) and the Office of Naval Research; Department of Interior, represented by the Bureau of Commercial Fisheries; Department of Commerce, represented by the Coast and Geodetic Survey and the Weather Bureau; the Atomic Energy Commission; and the National Science Foundation.

• **Money for the Center**—Speaking about budgets for NODC, Jacobs said "I would like to see them as a function of total national or international oceanographic efforts." He added "We're trying to get this figure right now. . . . As a guess, I see it between three percent and ten percent, excluding R&D for instrumentation and other equipment."

(Last spring, the Interagency Committee on Oceanography estimated that the national expenditure for oceanography during FY '62 will be about \$80 million. In his March 29 message to Congress, President Kennedy called for a national program level of \$97.5 million for oceanography—an increase of \$44.5 million or about 81% over FY '61.)

• **A mammoth job ahead**—The Center began life with an appreciable volume of data on hand, mostly transferred from the Hydrographic Office. At the present time, the NODC collection consists of over two million punched cards of physical and chemical data for the North Atlantic Ocean alone, nearly 700,000 bathythermograph prints, and several million wave and sea-surface temperature observations.

For the next two or three years, the Center expects to concentrate its efforts on processing data for the North Pacific and Indian Ocean. NODC has already formulated data exchange agreements with Canada and Japan and expects to develop exchanges with other countries.

Other programs being considered are the Tropical Atlantic and Eastern Tropical Pacific (EPOC). NODC is striving to be ready to take care of the data-handling, reduction and dissemination for these vast efforts.

Moreover, International Data Center A will shortly be associated with NODC. It is now moving out of Texas A&M, where it was functioning during the International Geophysical Year.

(International Data Center A has its counterpart (B) in Moscow, and both are part of a data-gathering complex

in a follow-on effort to IGY. All indications are that the oceanographic part of this new effort will have a far larger scope than the oceanographic work done during IGY.)

• **Limit the data**—Jacobs recoils at the idea of having to handle a volume of data equal to that coming in from our space effort. Actually, the volume of data from the oceans could be far greater than from space because of the greater number of variables in the sea. Noting this, Jacobs asserts that it is fundamental to take no more data than can be assimilated. "This is integral to the NODC program."

The need is to get the most information for the smallest number of "bits." One possible way is to record or transmit information by "exception";

failure of some raw-data processing facility.

—Data should either be in a format immediately compatible with the most advanced data-processing system or rapidly and economically convertible to a compatible format *without manual steps*.

—Where sequential data are concerned, the format of the data record should not irrevocably determine the sequence and order of data storage.

—Provision should be made for permanent retention of semi-processed as well as raw data.

—Wherever possible, records from two or more related instruments should easily allow quality control through cross-checking.

The Center now processes only



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that is, only those data that depart from what is already known by oceanographers should be sensed and processed. It follows that redundant information and "noise" should be filtered out.

In some instances, parameters may be more efficient data-carriers than sensed data; and here, good use might be made of internal data-processing.

Jacobs suggests using a "modular" approach in getting, processing and storing data. "We cannot afford a special curve-tracer or transcriber for each instrument, nor can we afford to employ an excessive variety of storage and handling equipment."

Here are some of the features NODC considers "highly desirable" in instrumentation:

—Where telemetry is involved, there should be no loss of data through failure in electrical transmission or through

physical data: bathythermograph and ocean station data. Eventually, NODC will handle all types of marine geological, biological and ice data. The quest is to find out how to digitize such data. This will mark the first time such studies have been mechanized wholesale.

Two areas in particular are difficult to mechanize because there is so little precedent: marine geology and marine biology.

One problem is more psychological than mechanical. Most oceanographers, except possibly those in the Hydrographic Office, are lone wolves. Many of them design their own instruments, do the operations work, reduce their own data and publish their results. Some of these professionals would like to cling to their way of working. But they may have to give it up when oceanography is put on an ocean-wide basis. ❧

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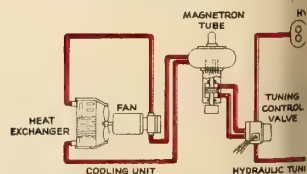
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| 410        | 0.87                          | 1.30        |
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| 0          | 60                            | 125         |
| -10        | 80                            | 170         |
| -20        | 110                           | 260         |
| -30        | 160                           | 380         |
| -40        | 240                           | 650         |
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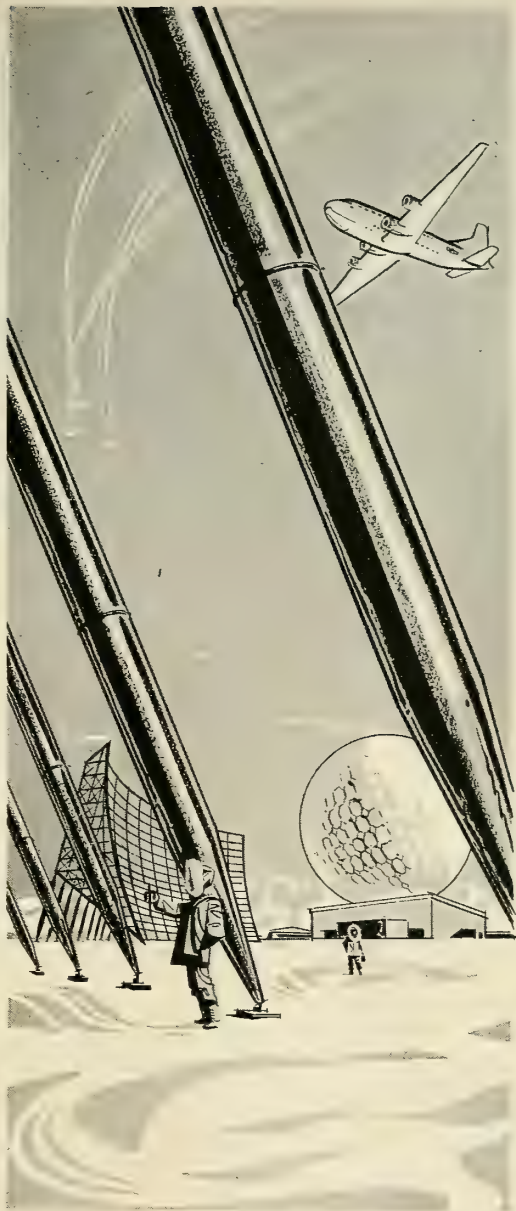
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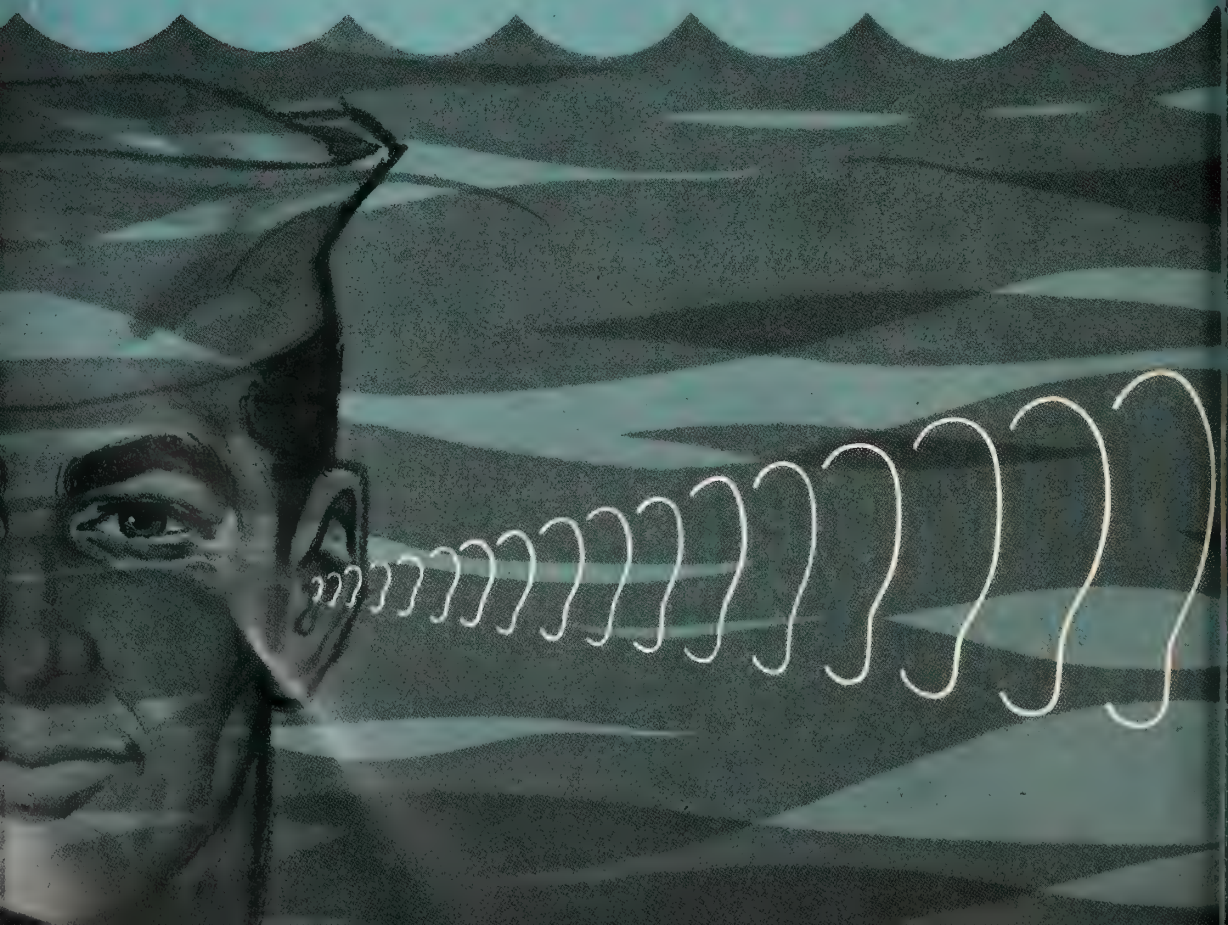
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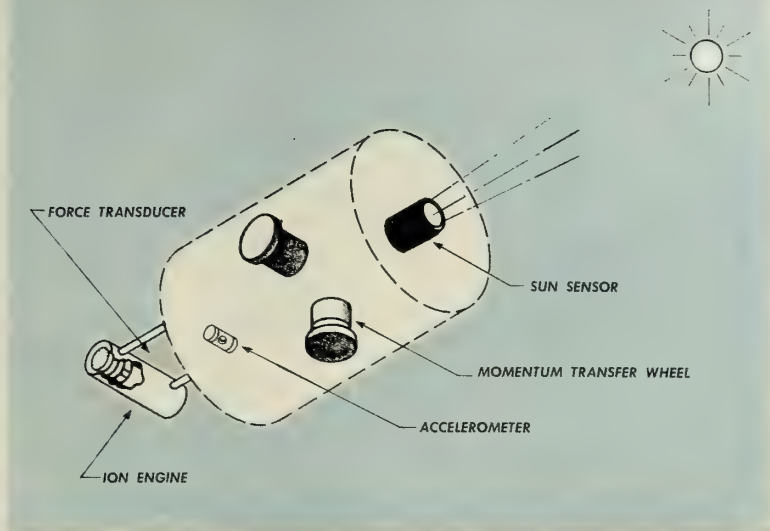
## Honeywell



*Military Products Group*







SCHEMATIC of two-axis stabilized ion engine test capsule proposed by EOS.

## electric propulsion

# EOS Urges 'More Realistic' Test

by Frank G. McGuire

A CONTROVERSY appears to be brewing over the best approach to testing electrical engines in space.

Questions are being raised as to whether the method NASA is planning to use in a shot next year will yield the best results. There also is considerable concern over the leisurely pace of the whole electrical propulsion program.

The first test is scheduled late next year. Two ion engines, one made by Hughes Aircraft and the other by NASA's Lewis Research Center, are to be mounted aboard a capsule and fired deep into space by a *Scout*. Batteries will furnish the power to the engines.

In the second shot, sometime late in 1963 or early 1964, an Electro-Optical Systems Inc., ion engine and a Plasmadyne Inc. plasma-arc engine are to be orbited aboard a satellite. They will be powered by nuclear *SNAP II* and *Sunflower* (solar) units, generating 2 to 3 kw.

In the first experiment, the capsule will be spin-stabilized by the two ion engines. Thrust of the engines will be measured by variations in the spin rate.

EOS is presently taking issue with this procedure—even though its engine

isn't involved, contending that the effects of thrust will be integrated over a longer period than necessary, instead of giving an instantaneous indication of performance. As an alternative, EOS is suggesting what it terms a "more realistic" method.

Based on launchings by *Scout* rockets, the EOS proposal involves a ballistic lob to altitudes of about 3200 miles, during which a test capsule containing one engine would operate in space for at least 10 minutes.

Principal objective of the test would be to study neutralization, but some 20 other significant parameters, including correlation of ground and space test results, would also be measured.

Ronald S. H. Toms, Senior Scientist at EOS, said no neutralization problem whatever is expected in space—"now all we have to do is prove it."

EOS is currently responsible for filling space test needs of both NASA and the Air Force.

"Space testing is clearly not an end in itself," Toms argues, "and it is possible that the requirements for space testing have become somewhat out of perspective."

The 250-lb. test capsule envisioned by EOS would contain an ion engine

capable of about 3.2 millipounds of thrust, two small reaction wheels, a sun sensor, accelerometer, force transducer, and several other accessory components.

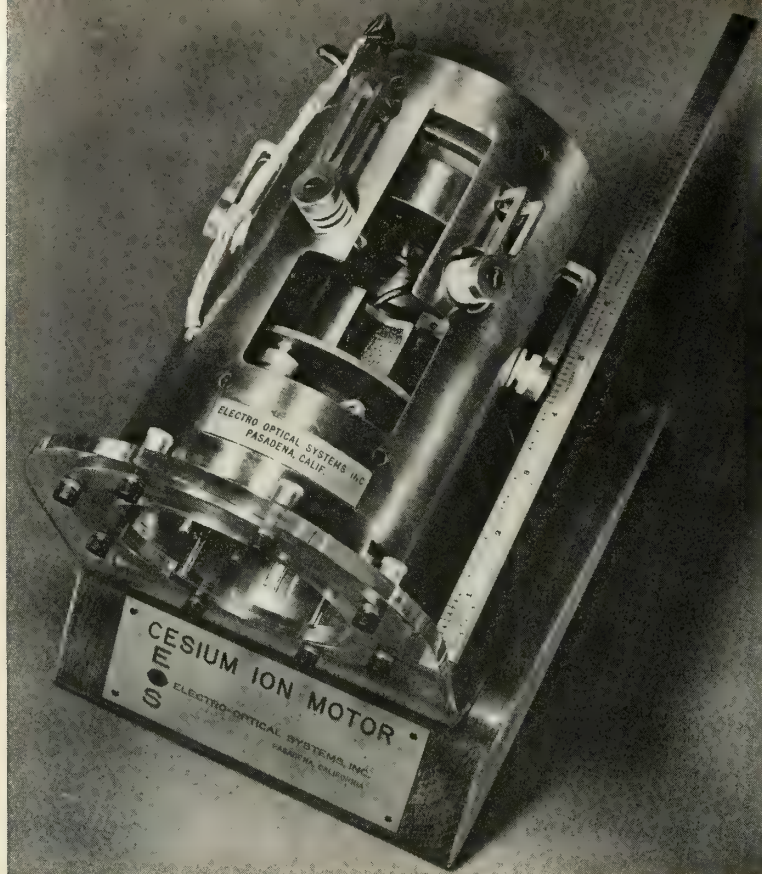
Most of the weight would be in the batteries used as a power supply. The reaction wheels would weigh about 6 lbs. each, the ion engine itself 5 lbs. or less, and a cesium expellant just a few ounces.

The ion engine would not be a highly efficient model. It was deliberately designed for operation at less than optimum conditions, in order to simplify control systems. Constant heating power and voltages would be supplied to make engine operation predictably safe and steady, even though at less than peak efficiency.

• **Test method**—At approximately launch time, the ionizer heater would be turned on in the payload. During the ascent phase, the cesium reservoir, acceleration-deceleration voltages, neutral efflux detector, and neutralizer electrons, would be turned on.

Engine operation would begin at about T-plus-five minutes—slightly below 800 miles altitude, after fourth-stage burnout has occurred probably at 400 miles altitude.

The shroud surrounding the payload



CUTAWAY CONCEPTUAL design of Electro-Optical's flyable ion engine, based on company program which produced a demonstration engine with 3.2 millipounds thrust.

| SYMBOL          | PARAMETER                                                 | EXPECTED OPERATING CHARACTERISTICS |                           |                          | METHOD OF MEASUREMENT                       |
|-----------------|-----------------------------------------------------------|------------------------------------|---------------------------|--------------------------|---------------------------------------------|
|                 |                                                           | DESIGN VALUE                       | EXCURSION                 | REPEATABILITY ( $\pm$ %) |                                             |
|                 | PURPOSE<br>— TO DETERMINE —                               |                                    |                           |                          |                                             |
| BM <sub>0</sub> | Ion Beam Oscillations                                     | $\pm 10$ ma                        | 0~20 ma                   |                          | Voltage drop across resistor                |
| F               | Thrust                                                    | $2 \times 10^{-3}$ lbs             | 0~ $3 \times 10^{-3}$ lbs | 10                       | Micro G accelerometer, spin or displacement |
| I <sub>A</sub>  | Accelerating Electrode Drain Current                      | 10 ma                              | 0~20 ma                   | 3                        | Voltage drop across resistor                |
| I <sub>C</sub>  | Ion Beam Current                                          | 90 ma                              | 0~150 ma                  |                          | resistor or transducer                      |
| I <sub>D</sub>  | Decelerating Electrode Drain Current                      | 0 ma                               | 0~20 ma                   | 1                        | "                                           |
| I <sub>E</sub>  | Emitter Current                                           | 100 ma                             | 0~150 ma                  | 1                        | "                                           |
| I <sub>J</sub>  | Neutral Efflux                                            | 1.5 $\mu$ a                        | 0~5 $\mu$ a               | 3                        | "                                           |
| I <sub>N</sub>  | Neutralization                                            | 90 ma                              | 0~150 ma                  | See Remarks              | Voltage drop across resistor                |
| P <sub>CS</sub> | Cesium Reservoir Pressure                                 | 30 mmHg                            | 0~50 mmHg                 | 3                        | Pressure transducer                         |
| P <sub>E</sub>  | Power Required to Maintain T <sub>E</sub> at Design Value | 270 W                              | 0~300 W                   | 3                        | Voltage drop across resistor                |
| P <sub>L</sub>  | " " " " T <sub>L</sub> " " "                              | 20 W                               | 0~50 W                    | 3                        | "                                           |
| P <sub>N</sub>  | " " " " T <sub>N</sub> " " "                              | 12 W                               | 0~25 W                    | 3                        | "                                           |
| P <sub>R</sub>  | " " " " T <sub>R</sub> " " "                              | 10 W                               | 0~25 W                    | 3                        | "                                           |
| SH <sub>N</sub> | Space Ship Outermost Surface Charge                       | 0                                  | 0~15 kv                   | 1                        | Langmuir probe                              |
| T <sub>A</sub>  | Accelerating Electrode Temperature                        | 500°C                              | 0~1000°C                  | 3                        | Voltage drop across resistor                |
| T <sub>D</sub>  | Decelerating " " "                                        | 250°C                              | 0~500°C                   | 1                        | "                                           |
| T <sub>E</sub>  | Emitter Temperature                                       | 1250°C                             | 0~1500°C                  | 5                        | "                                           |
| T <sub>J</sub>  | Neutral Efflux Sensor Temperature                         | 900°C                              | 0~1500°C                  | 3                        | "                                           |
| T <sub>N</sub>  | Neutralization Filament Temperature                       | 1500°C                             | 0~2500°C                  | 3                        | "                                           |
| T <sub>R</sub>  | Cesium Reservoir Temperature                              | 350°C                              | 0~500°C                   | 3                        | "                                           |
| T <sub>S</sub>  | Space Ship Outermost Surface Temperature                  | 400°C                              | 0~600°C                   | 10                       | "                                           |
| V <sub>-</sub>  | Accelerating Electrode Voltage                            | 15 $\pm$ 1 kv                      | 0~16 kv                   | 2                        | "                                           |
| V <sub>D</sub>  | Decelerating " " "                                        | 0                                  | -30~+30 kv                | 2                        | "                                           |
| V <sub>E</sub>  | Emitter Voltage                                           | 3.5 kv                             | 20~5 kv                   | 2                        | "                                           |
| V <sub>J</sub>  | Neutral Efflux Sensor Filament Voltage                    | 30 V                               | 20~50 V                   | 2                        | "                                           |
| V <sub>N</sub>  | Neutralizer Bias Voltage                                  | 30 V                               | 0~50 V                    | 1                        | "                                           |
| X <sub>D</sub>  | Cesium Reservoir Valve Position                           | 1 cm                               | 0~2 cm                    | 1                        | "                                           |

Chart of Flight Measurements

would be left in place for the first part of the test operation, in order to simulate the walls of a vacuum chamber in a laboratory test. Correlation would be made between these test results and results from later tests without the shroud. Shroud ejection is planned for about 2500 miles altitude.

The capsule will be attitude-stabilized on two axes by use of the sun sensor and reaction wheels. The *Scout* fourth stage will be spin-stabilized for the launch; to de-spin the payload for achieving test conditions, a solid-propellant rocket and a cold-gas system will be used. This technique is expected to reduce angular velocity about the third axis to an insignificant amount.

The thrust from the ion engine will be used to destabilize the test capsule so that the reaction wheel torquing about the same axis will react against it and accumulate the work done by the engine torque.

With this method, up to five measurements of the thrust can be made by pickoffs from the sun sensor, reaction wheels, accelerometer, internal force transducer, and electrical measurements of the ion beam.

EOS feels the results would corroborate each other and provide a more accurate and meaningful test than one like NASA's, in which the ion engine is used merely to change the spin rate of a stabilized capsule.

• **Neutralization** — The neutralization problem boils down to this: without a neutralized beam, there can be no thrust. EOS scientists point out that it is unnecessary to achieve complete neutralization on an atomic scale—that is, each ion does not have to capture an electron from the neutralizing electrode.

"It is sufficient," said Toms, "if the beam is essentially neutralized over dimensions quite small compared with the accelerating gap surface."

An insufficient neutralization of the beam would cause a buildup of space charge, resulting in a retardation of the ions and a subsequent dispersion of the beam, with many ions returning to the space vehicle and causing loss of momentum.

Neutralization cannot be fully measured merely by determining thrust levels, however, and another technique would be used for this purpose. The charge developed on the outer shell of the payload would be constantly monitored to detect any current flowing back into it as a result of returning ions.

The many other objectives of the flight would include determinations of all thrust variations, engine operation in zero-g, component reliability, possible interference with vehicle telemetry, possible sparking of an aura, beam oscillation, power efficiency, and propellant efficiency.





## SCIENTISTS AND ENGINEERS:

### Follow-On Atlas Programs Mean New, Long-Range Opportunities.

Now operational, the Atlas weapon system stands as a unique symbol of scientific, engineering and military achievement. The design, development and testing of this reliable missile were undertakings of immense complexity.

Scientists and engineers at General Dynamics | Astronautics worked constantly at the most advanced state of the various arts involved. Boldly, they introduced and proved entirely new concepts of rocketry, and in record time they developed the Atlas.

The same depth of imagination and technical daring is now at work modifying and adapting this sophisticated machine for a variety of civilian and military space missions. Dozens of specialized orbiting and interplanetary vehicles will depend upon the power of Atlas to thrust them into space.

These programs reach far into the future and require the skills of highly resourceful engineers and scientists in many technical disciplines.

Atlas is the free world's first intercontinental ballistic missile; the first missile to travel more than 9,000 miles across

the earth's surface; the only one to lift itself into orbit. Atlas marked the first use of swivel engines for directional control and it was the first to use airframe skin as fuel cells.

Many more "firsts" lie ahead for this reliable rocket. If you are the sort of inventive engineer or scientist who can contribute ideas and solutions to the problems surrounding the mastery of space, you and General Dynamics | Astronautics have a common interest.

*You'll find most of the details on this and the following page, plus a convenient inquiry card. If the card has been removed, or if you wish to furnish or request more detailed information, write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Dept. 130-90, General Dynamics | Astronautics, 5705 Kearny Villa Road, San Diego, 12, California. (If you live in the New York area, it may be more convenient to contact Mr. T. Cozine or Mr. E. Hart, General Dynamics | Astronautics, 1 Rockefeller Plaza, New York City, Telephone Circle 5-5034.)*

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# ENGINEERS AND SCIENTISTS



General Dynamics | Astronautics is located in San Diego, California, one of the fastest growing communities in the United States. It is situated 10 miles north of the Mexican border and a little over 100 miles south of Los Angeles.

Immediate openings exist in the following areas:

**SCIENTISTS & ANALYTICAL ENGINEERS:** PhD or ScD for electronics and physical research; computer analysis and application; and instrumentation development.

**ELECTRONIC DESIGN & TEST:** Communication systems and data transmission design; logical circuitry; automatic control systems; and electronic packaging. BSEE plus appropriate experience required.

**MECHANICAL DESIGN:** BSME or AE for pneumatics, hydraulics, and fluid systems design and test. Also missile GSE and missile structures designers.

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**ENGINEERING WRITERS** with 2 years of college and 1 to 3 years of experience in preparation of TCTO's; operations, maintenance, and overhaul manuals.

**BASE ACTIVATION:** Design or liaison engineers with BE in ME or EE and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations. Assignments are at Lincoln, Nebraska; Altus, Oklahoma; Abilene, Texas; and Roswell, New Mexico.

**FIELD TEST ENGINEERS:** Electrical engineers for test and validation of complex power electrical systems using standard commercial equipment. Trouble shooting and checkout of ground electrical equipment including lighting, systems through missile-borne power distribution, fire alarm instrumentation and control. Must be thoroughly familiar with motor generators, motor control centers, AC and DC power and control circuits. Openings at Vandenberg and Edwards AFB, Calif.; Cape Canaveral, Fla.

If you desire to become part of this great team, we urge your prompt inquiry on the attached Professional Placement Inquiry.

*Technical openings also exist in other specialties. Write Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Dept. 130-90, General Dynamics | Astronautics, 5705 Kearny Villa Road, San Diego 12, California. (If you live in the New York area, it may be more convenient to contact Mr. T. Cozine or Mr. E. Hart, General Dynamics | Astronautics, 1 Rockefeller Plaza, New York City, Telephone Circle 5-5034.)*

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## ASTRONAUTICS GENERAL DYNAMICS

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# Processor Displays Data in Seconds

**OPTOmechanisms system expected to widen potentials of satellite/missile tracking, ASW**

by Martin M. Saffian\*

A RAPID FILM PROCESSOR has been produced to satisfy the long-standing need for a flexible, automatic system supplying almost immediate viewing access to an observed event.

In addition, the device provides a photographic negative of archival quality, with very high resolution and a full range of contrasts.

Called the Series 380 Rapid Film Processor, the system was developed by OPTOmechanisms, Inc. in its research laboratory at Mineola, N. Y.

Typical applications include the recording of track and target information on radar and sonar PPI's, instrument-face dial readings, and time-stop sequence photography in biological and chemical experiments. Developers believe it can be a highly effective tool for expanding the potentials of satellite and missile tracking, air traffic control, anti-submarine warfare, and similar systems.

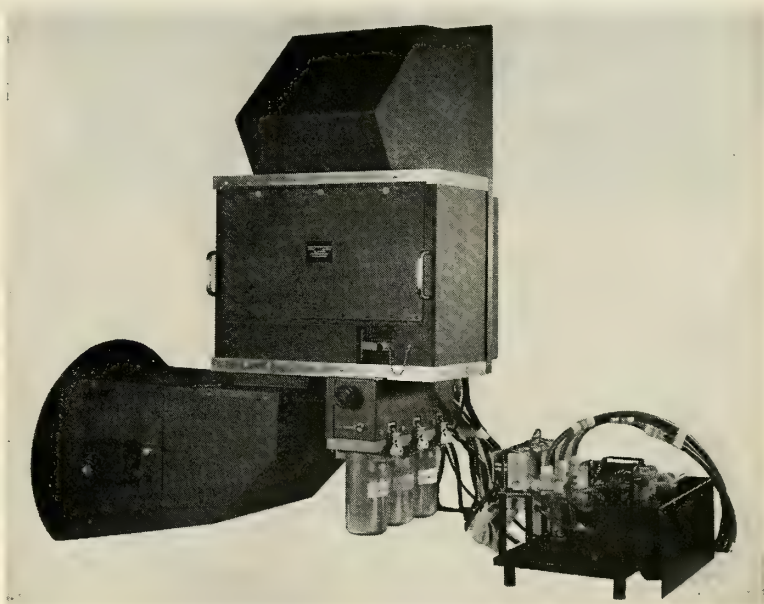
The equipment is fully automatic; an operator is needed only for loading film and chemicals and for periodic cleaning. Total time required—including film exposure, development, fixing and washing—is 6 seconds.

The resolution currently attainable easily exceeds 80 line pairs per millimeter; this, using 35mm film, is equivalent to over 4600 TV lines. Present models use 35mm perforated on daylight loading reels, with no limits imposed on film capacity save the user's physical size restrictions.

• **Operation and processing**—The system consists essentially of a camera, a patented processing head, and a projector mounted into a single unit, together with film-feed mechanisms and other associated hardware. Dimensions are 19 in. wide x 14 in. high x 8 in. deep.

In its usual mode of operation a single-frame photograph is made of the object under study on either a preprogrammed basis or at random commands from some outside source. The

\*Sr. Project Engineer, OPTOmechanisms Incorporated, Mineola, L. I., N. Y.



*RAPID FILM PROCESSOR developed by OPTOmechanisms, Inc., provides data display and a permanent film record in seconds after an observed event has occurred. Camera-Processor-Projector (center) is heart of system. Pump and drive assembly (right) and rear and side viewers (top and left) complete system.*

exposed frame is indexed into the film processing stations, while a fresh photographic frame is simultaneously positioned within 0.1 sec. ready to make a new exposure. The previously exposed frame is automatically advanced through the three states of processing—that is, develop, clear/fix, and wash.

The processed negative is then projected onto either a rear- or front-projection screen, with any degree of magnification required by the user. The processing section can be adapted to monobath operation without major change to the device itself.

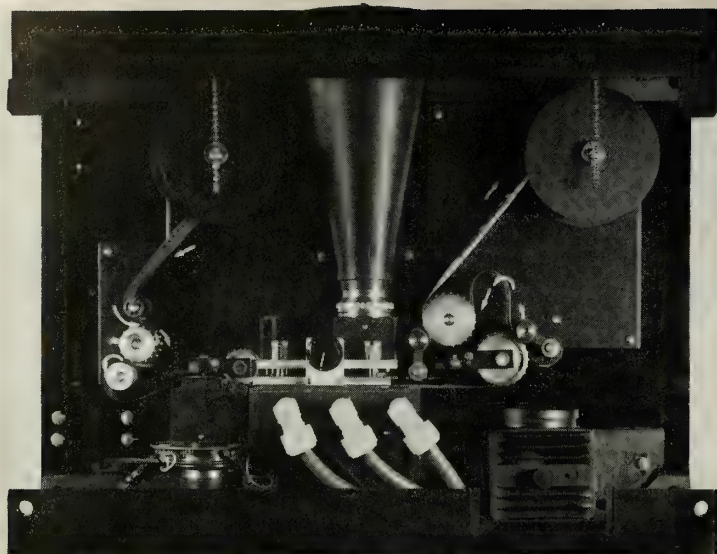
It is important to note that although total processing time is of the order of 6 seconds, this consideration has no effect on the maximum repetition rate at which new exposures may be made, since a variable-length film loop is allowed to form between the camera sta-

tion and the first processing station. This permits a short-time maximum rate of exposure as high as 10 frames/sec.

• **Safe fluid flow**—Freedom from leakage and uniform fluid flow over the emulsion are assured by using specially designed molded silicone rubber gasketing around the processing chambers. This, coupled with a negative-pressure hydraulic system, makes the processing section completely leak-proof under all operating conditions.

The processing fluids are flowed over the emulsion; there are no jets to clog, nor is compressed air required. The film leaves the processing section virtually dry.

Processing chemicals are stored in stainless steel tanks which are positively foolproofed as to their position. The tanks can be inserted or removed in



**CAMERA-PROCESSOR-PROJECTOR** unit is shown with cabinet removed. Fully automatic, the system completes 35mm film processing in six seconds and projects frame. Resolution is better than 80 line pairs per millimeter.

seconds. Each can contain a coiled electric immersion heater, a thermostat, and fluid inlet and outlet connections. An important feature of the storage tank module is that it may be located at any convenient place in the user's system, or, alternately, may be attached to the processor itself. The module's dimensions are approximately 10 x 8 x 3 in.

Processing fluids are pumped from the storage tanks through the processing head by a single peristaltic pump which handles all three fluids (developer, fixer, and wash water) but does not mix them. The pump and drive motor module may also be located at any distance from both the processor and the storage tank module.

Color-coded polyethylene tubing and nylon fittings are used for fluid interconnections. A major safety and convenience feature is that the pump is self-priming and self-cleaning. The design is such that there is never any need for priming the fluid tubes to establish proper pressure relationships.

• **Electronic uses**—There is a high degree of freedom in the placement of the processor, tanks, and pump in that their proximity, or lack of it, to one another is of no importance to proper operation. This eases the problem of placing the equipment within a console which contains other electronic gear. In addition, freedom from fluid leakage obviates the danger of short circuit and corrosion damage to other components.

The processor has the advantage of being absolutely flexible as to film materials and processing chemicals which may be used successfully, and without

modification to the device itself. If at some time after the processor has been installed it is desired to change film material and/or chemicals, this may be accomplished by merely adjusting two potentiometers which control the time sequence in the processing head.

• **Film/chemical requirements**—Tests run at our laboratories indicate that any thin, pre-hardened emulsion film—including Ansco Hyscan, Eastman Kodak SO-264, and Ilford Types BU and BX—may be used interchangeably with consistently superior results. Processing solutions covering a wide variety of chemical formulations may also be interchanged at will.

Developers such as Ansco Liquidol X-Ray developer, Ansco Hyscan developer, Eastman Kodak PS-480 developer and others have all been successfully used with various film materials. The Series 380 processor is also adaptable to monobath processing, although the monobath processing interval is somewhat longer than 6 seconds.

The processor itself is capable of considerably faster than 6-second operation; the limit is now determined by the present state of the photographic chemical art.

• **Operating modes**—Various modes of operation may be obtained to suit the user's system requirements. In general, modifications of this type involve the programming of film movement and the judicious placement of film storage loops to provide many mode variations.

For example, one modification might be for making continual exposures on many feet of film, at any repetition rate, including cine, for some

minutes, and then viewing the processed frames one at a time, starting 6 seconds after the first exposure, for either a fixed or variable time period.

Projection back tracking is also available, as is digital coding placed on the side of each frame. The simplest and least costly method is to make exposures at the same repetition rate as the processing rate; this, too, is available.

It is also possible to provide prior processing so that a frame exposed later in a sequence may be processed and projected for viewing immediately when the need arises.

The processor adapts itself very well to continuous strip processing, such as might be required for line-scan radiography or cartography, by changing the film movement mechanisms from the Geneva-type pull downs used in a frame-by-frame system to a continuous drive which can move the film at rates as high as 0.5 ips.

OPTOMECHANISMS feels that the variations obtainable in regard to operational mode are virtually limitless.

The processor can be adapted any time to give a reversal image (a positive projection). If this is done in the conventional manner of rapid film processors, an additional 5 seconds for processing would be required. Also, double the number of solution tanks and processing stations would be required—in effect, almost doubling complexity of the system.

If the user's requirement demands a positive projection, a patented negative-to-positive projection screen would be recommended. This device makes possible either positive or negative viewing of a film negative by the flick of a switch, and requires no alteration in the actual processing section.

An interesting application of the combined system would be in the traditional day/night viewing of radar scope PPI information. During daylight the processed negative would be viewed directly as a black-on-white image; at night, however, it would be viewed as a positive white-on-black.

OPTOMECHANISMS' system is the only rapid processor now available which can provide positive image projections with the same short access time as those which project negatives on. Further, the film record remains negative. This has the advantage of single-step printing later, if required; also saves the original film from additional chemical treatments.

Finally, the denigrating effects of contrast and background fog levels which cannot be avoided in conventional rapid-reversal processing are encountered in this system, since the film is processed in the normal develop/wash cycle.



The new underwater acoustic test laboratory pictured below will be in operation this year in Baltimore, helping Westinghouse engineers solve problems in oceanographic and ASW research.

Built by the Westinghouse Ordnance Department, the new laboratory is one of the largest and best-equipped privately-owned facilities of its kind. It is 205 feet long and 175 feet wide. The air-conditioned instrument house floats on a 3½ million gallon lake, 25 feet deep and with an anechoic lining.

The laboratory will advance the develop-

ment of a wide range of Westinghouse underwater acoustic equipment. Included are transducers, detection systems, weapon homing and guidance systems, and high and low frequency sonar devices.

Underwater acoustic systems built by Westinghouse are a part of various Navy weapon systems. This new acoustic laboratory at Baltimore will bring continued contributions to this vital area of American strength.

Defense Products Group, 1000 Connecticut Avenue, N.W., Washington 6, D. C.

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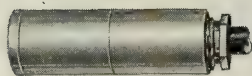
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Westinghouse

UNDERWATER ACOUSTIC LABORATORY...in our own backyard



# MASSA ADP MICROPHONES

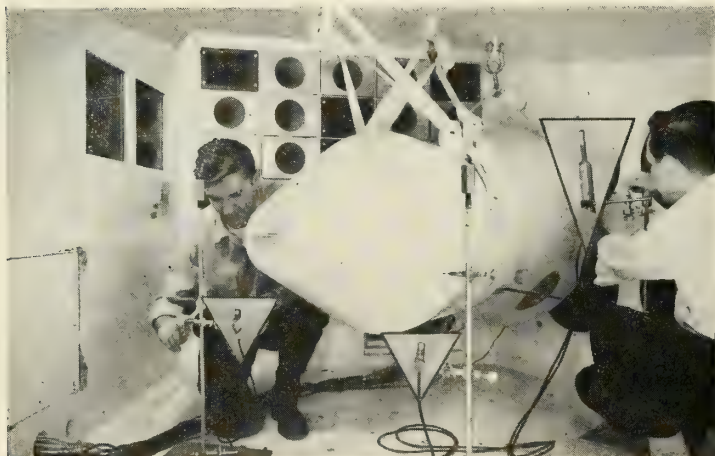


M-141



M-125

are selected for exacting applications in  
**AVCO MARK 5**  
re-entry vehicle test



Three Massa Microphones (two M-141's and an M-125) with M-114B Preamplifier measure sound levels which simulate missile noise.

MASSA A.D.P. (Ammonium Di-Hydrogen Phosphate) Sound Pressure Microphones are used to measure sound pressure levels in an acoustic chamber at the Avco Research Center, Wilmington, Mass. Missile sound is simulated by noise generators that reach intensities as high as 143 db \*. Placed at strategic locations, the Massa S.P. Microphones accurately determine that specified sound levels are reached at critical points on the vehicle.

Massa Sound Pressure Microphones employ A.D.P. crystal plates as the mechanical impedance determining element which results in an exceptionally stable vibrating system that does not distort the sound field in which the microphone is placed. A.D.P. crystal plates are employed as the active elements for best combination of reliability, stability and accuracy. The frequency response, essentially flat from 10 cps to 80 kc, extends well into the ultrasonic region. The dynamic range is linear to levels in excess of 200 db.

\* Above 0.0002 dynes/cm<sup>2</sup>

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## Bendix Finishes First Part of Computer Center

THE FIRST PHASE of an extensive new computer center being developed by the Bendix Corporation is now in operation at the company's systems division, Ann Arbor, Mich.

The \$1-million center, when completed in the spring of 1962, will considerably increase the company's digital computer facilities and will also be adaptable to PERT and similar computer-controlled management methods.

A high-speed G-20 digital computer designed and developed by Bendix, will be featured within the new facility. The G-20 will consist of four memory modules capable of storing 32,768 words, and eight magnetic tapes which can simultaneously search for information at a combined speed approaching 2 million characters per second.

The computer can perform 83,000 additions or subtractions per second and will be capable of magnetic-tape read or write operation at a rate of 240,000 alpha-numeric characters per second. A high-speed line printer is also installed and will operate at speeds up to 1000 lines per minute. Mathematical translation and linear programming capabilities will also be available.

In addition, analog computer facilities for dynamic simulation efforts and a BOSCAR reader for data reduction display will be housed within the Bendix Center.

## NBS Compiling Radio Wave Refraction Data

SCIENTIFIC GROUPS in government and industry interested in radio wave propagation in the earth's atmosphere will get an assist from the National Bureau of Standards.

The Bureau has established a Radio Refractive Index Data Center at 1530 Boulder, Colo., laboratories. Data collected at this installation on the variable refraction of radio waves at specific times, heights, and locations will be correlated and made available to interested study groups.

A central information source in the field will aid considerably in such areas as: evaluating missile tracking and guidance systems; establishing error correction for height-finding radars; predicting transmission loss for tropospheric communication links; and estimating radio wave field strengths for various types of radio propagation.

Information from more than 30 reporting points throughout the world is received by the center, which is now equipped to correlate data for specific areas and to establish radio-refraction profiles for those locations.

missiles and rockets, November 20, 1961



# Heat-Treat Unit Ready For Big Booster

LANSDALE, PA.—The world's largest heat-treating furnace specifically designed to handle up to 140-in.-diameter solid motor cases is rapidly approaching completion at the J. W. Rex Co.

The massive gantry unit stands 40 ft. high, with an inside work area 12 ft. in diameter and 32 ft. tall. The furnace can easily treat the current 120-in. diameter case under consideration by the Air Force and approved for development by the joint NASA-DOD Committee on large boosters.

Power requirements call for 1000 kw generating a maximum temperature of 1850°F. The atmosphere is endothermic and automatically controlled and recorded. The same type of control units apply to temperature functions.

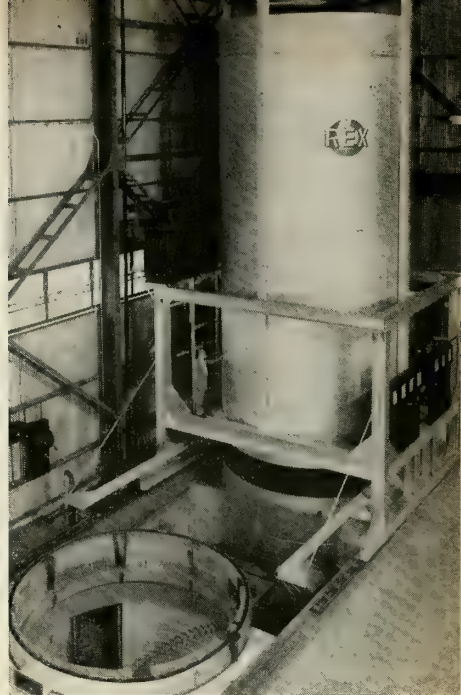
A gas-fired, circulating-fan tempering furnace pit 13 ft. in diameter and

42 ft. deep can reach temperatures of 1250°F. The pit can also be used as a loading station or for a forced air quench.

The quench tank has the same dimensions as the tempering pit and can handle either air, oil or salt quench. The big booster cases will be air-quenched.

Plans have been made to extend this furnace's capability to the larger diameter booster case being talked about in various propulsion circles. Rex spokesmen caution that the furnace modification would be a major undertaking but it would not take any 9 months to complete.

No move will be made by Rex until some definite decisions are made with regard to the larger solid chambers. If such a furnace was built and no market existed, it might be an expensive



*UNDER construction for a year, huge furnace easily handles 120-in. cases.*

liability.

Even with the 120-in. chambers, there is a great deal to be learned. Heat-treating experience in this area is all but non-existent. The huge furnace is not immediately ready for heat-treating operations but can be available within two weeks. \*\*

## Missile Bearings Now Mass-Produced

BEARINGS WITH tolerances within 20 millionths of an inch are in production at the Barden Corp. and each bearing carries its own case history documentation to the users—all current U.S. ICBM's.

Barden started into development of the extremely accurate bearings five years ago in cooperation with MIT Instrumentation Laboratory under Air Force sponsorship.

Volume production of the bearings resulted from three main principles set up during the research and feasibility phase. New methods of chucking during critical grinding processes had to be developed. Stress relieving would have to be done after rough grinding and the creation of new stresses minimized by removing very small amounts of stock in the final grinding and lapping operations.

Finally, machine-driven gages had to be developed for measuring critical dimensions, since measurements in the millionths-of-an-inch range required elimination of operator-induced errors.

The oil-impregnated phenolic retainers received special attention; these serve not only as ball separators but

also as lubrication sources. The initial lubricant charge is only a few milligrams, but this must last for thousands of hours of operation.

Gages designed for the bearings involved two principles new to mass-production bearing techniques—motor drives and recorded readouts. Since the heat of the hand and variations in hand pressure affect measurements this precise, the operator was replaced by power-operated gages. The readings themselves are recorded on calibrated charts.

Cleanliness is a normal part of bearing manufacture, but in this case, finishing operations are almost fanatical.

Just prior to assembly, the finished inner and outer rings are gaged and sorted according to differences of a few millionths within the overall tolerance range. Balls are also classified to size in the same manner.

An inner ring, outer ring, retainer and balls—all of matching dimensions—are assembled to form a 20-millionths ball bearing.

After assembly, actual contact angle is measured—a necessary step since the angle is critical to the proper operation

of these bearings. If the angle is not within tolerance limits, the bearing is disassembled and rebuilt with other balls to achieve the required characteristics.

Slow-speed running torque of the assembled bearings is checked on the Torkintegrator, a device developed by the firm to precisely measure the force needed to overcome internal bearing friction.

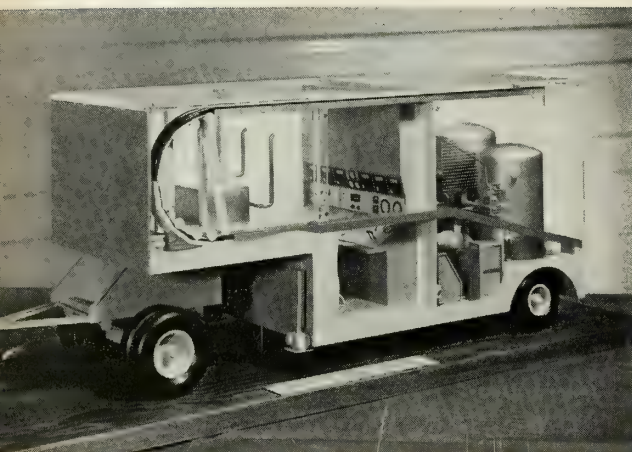
A preload gage measures stickout of inner to outer ring under a specified thrust load. This accompanies the bearing to the final user.

After passing these final tests, the bearing is re-impregnated with the precise amount of oil lost during the check-out operations and packaged.

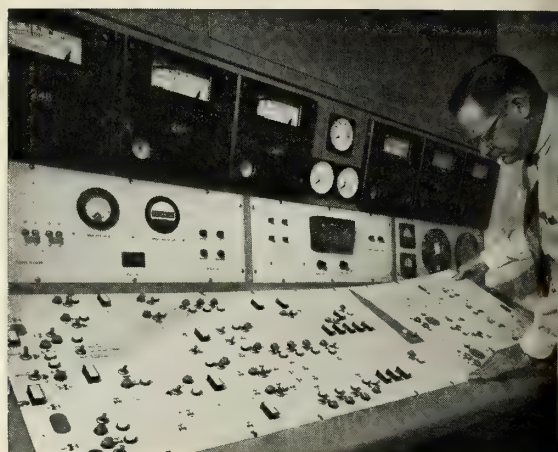
In all there are more than 100 manufacturing and assembly operations connected with the production of a single missile bearing.

All documentation, including a separate tally sheet for inner and outer ring dimensions, is shipped with each bearing. All dimensions are usually well under the specifications—ring dimensions being accurate to 10 and even 5 millionths. Balls are controlled to 3 millionths. \*\*

# Mobile Atlas System Saves Money



*CUTAWAY MODEL shows positioning of pressurized helium storage tanks, control panel and electrical cables.*



*OVERLAY with name and function of each switch can be replaced for checkout of a semi-hard, horizontal ICBM.*

by James Trainor

A SINGLE MOBILE ground support unit is saving Air Force money at hardened *Atlas* ICBM sites throughout the country. Housing two previously stationary pneumatic service units, it performs periodic checkout for several launching sites—eliminating the need for identical stationary equipment at each site.

Specifically, the mobile support system—developed for the Air Force by Consolidated Systems Corp.—performs regular prelaunch checkout of the missile's pneumatic system and is also used to verify operation of stationary, pneumatic ground support equipment. In addition, it can manually or automatically conduct tests at the missile assembly and maintenance areas.

• **System description**—To accomplish these functions, the system has four pressure controller subsystems rated at 3500, 1500, 70 and 35 psig, respectively. A manual missile tank-pressure system has also been included in the semi-trailer.

All test pressures are manually selected or adjusted, using four of the six controllers mounted on the control console. The two additional controllers provide variable relief pressures for the primary and secondary pressure systems.

The primary pressurization system,

operating at 500-3500 psig, performs proof pressure testing at the launch site. It is monitored by a 1% pressure transducer which supplies a digitized reading to facilitate pressure adjustments and to eliminate operator errors in reading the electrical meter.

In addition to providing secondary pressure to three of the unit's pressurization systems, the 50-1500 psig system can be coupled with the primary system for operation at missile assembly and maintenance areas. This combination allows preliminary pressurization and leak tests to be conducted at pressures not exceeding 1500 psig.

Primarily, however, the 1500 psig secondary system supplies three subsystems: the liquid oxygen and fuel ullage pressurization systems and the manual missile tank pressure system. The first two provide the pressures for dynamic checkout of the missile's airborne pneumatic system; the latter maintains safe pressures in the missile fuel and LOX tanks during prelaunch handling and testing.

Special pneumatic hose assemblies stored on automatically retracting spring-motor-driven reels conduct the high-pressure gaseous media safely to the missile. Each hose consists of a doublet (or married pair) with a 1/2-in. hose for pressurization and exhaust and a 1/4-in. line for sensing missile tank pressures. Weighing only 35 lbs., a

120-ft. hose assembly allows working pressure of 1000 psig to be used.

• **Manual operations**—While the system is capable of automatic operation—particularly during missile checkout, manual mode is also incorporated into the equipment. This capability is essential for validation of other launch site equipment and for trouble-shooting of the missile and other GSE. This mode provides the overall system with the flexibility to perform multiple operations and to incorporate the demands imposed by design changes.

The basic control console—a simplified, graphic display of the pneumatic GSE at the silo or hard site—has been designed to facilitate the accomplishment of the test program and to reduce operator learning time. To do this pneumatic lines are color-coded to indicate the gaseous media they conduct.

Also, every component is identified by number and, in some cases, by a description of its function. Valve position switches incorporate colored light to indicate their open or closed positions. Finally, overlay panels are provided to re-identify all the switches and lights so that the mobile unit can be adapted to horizontal or semi-hard launch sites.

To insure the safety of the operators at the console, a 1/4-in. steel plate has been placed between the control console and the pneumatic compart-



ments. This is sufficient to protect the operators in the event of a rupture of the high-pressure pneumatic lines.

• **Layout eases maintenance** — By mounting all of the valves in a single vertical plane, the pneumatic plumbing within the van has been greatly simplified. Every valve is readily accessible for maintenance; no other units need be removed to reach it.

The electrical wiring, consisting mainly of Neoprene-jacketed cables, has been routed along the semitrailer walls for ease of both maintenance and storage. This technique, coupled with the fact that there are no large harnesses or multi-conductor cables to be maintained, makes it simple to maintain or replace an individual cable.

Conveniently located terminal boards provide tie points for instrumentation, monitoring or trouble shooting. Spare terminals have been provided to accommodate design changes.

• **Reliability test program** — To insure that only random failures and normal wearout would occur under field conditions, the mobile support unit was subjected to vigorous factory and field tests. The mechanical, pneumatic, pressure-monitoring and electrical systems were first verified in the factory. In addition, electrical cables were subjected to high-potential tests to verify that no damage had occurred to the electrical insulation during assembly.

A semiautomatic load simulator, designed to act like the GSE that the mobile unit will be used with, enables all of the electrical circuits to be sequenced and loaded. Each circuit must provide 1-2 amps. to the test load, with the voltage drop across the load being monitored on a go-no-go basis.

Once the factory tests have been completed, the fully loaded unit is given exhaustive road tests. These consist of maneuvers over paved highways, railway tracks, shallow ditches and 10 miles of un-improved, rocky roads.

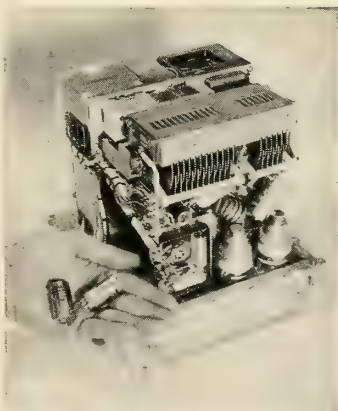
Abrupt stops from speeds of 10-20 mph and figure-eight turns to both the left and right on unimproved, irregular ground complete this phase of the testing. The system is then checked for evidence of damage, developing weaknesses or impairment of mechanical function. Reliability is verified by checking the overall system performance, design flows and rated accuracies.

The savings realized by this mobile pneumatic checkout system are clearly evidenced by the fact that it has eliminated the two identical systems previously in use at each launch site. Its versatility results from the fact that it can, thanks to its mobility, be used not only at hardened and semi-hardened CBM sites but also at missile assembly and maintenance areas. ■



U.S. Air Force photo.

## B-58's transmitter —“a kilowatt in a capsule”—uses Bristol choppers



Bristol Syncroverter Chopper (in hand) and 1000-watt power amplifier unit, cover removed.

The HC-101 Communication System, HACON, designed and built for the U.S. Air Force by Hughes Aircraft Company, Culver City, California, is the world's smallest airborne 1000-watt HF Receiver-Transmitter. This small, lightweight, high-performance transceiver was made possible through the use of high-quality components, such as the Bristol Syncroverter\* Chopper.

The Syncroverter Chopper is used as the d-c to a-c converter in the servo tuning system of the HACON Automatic Power Amplifier and was chosen because of its compact size, light weight, low noise, and ability to perform properly under the extreme environment produced by immersion in boiling fluorochemical.

In this application, the chopper has measured up to all expectations and has passed all acceptance and qualifications tests required of it.

The Bristol Syncroverter Chopper is used in a tremendous variety of airborne and missile-borne equipment—including literally dozens of missile guidance systems. On these exacting applications, the Syncroverter Chopper meets the high reliability standards required.

Send for complete details. More than 200 variations are available.

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\*T. M. Reg. U.S. Pat. Off.

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*INSTANT DEATH* came to rat in simulated space cabin with 100% oxygen, penetrated by hypervelocity particle.



*LEFT*—Effect of hypervelocity hit on unprotected .18 cm aluminum skin. *RIGHT*—Double bumper of .03 cm thickness.

## space medicine

# Rat Tests Show Meteoroid Hazards

by Heather M. David

NORMAL METEOROID conditions may wreak havoc upon living occupants of single-wall space vehicles.

Researchers at Vought Astronautics and the Southwestern Medical School of the University of Texas on the basis of intensive study say the potential danger of meteoroid impact may be graver than that of cosmic radiation. Indeed, there is some doubt that pressure suits of the conventional type will be sufficient protection in case of meteoroid penetration.

Damages to living creatures may range from burns, blindness and shock to death. And damages in a chamber with 100% O<sub>2</sub> at 5 psia were far greater than those in a sea-level atmosphere chamber.

Using various existing data on the space environment to set upper and lower impact probability limits, a research group at Vought Astronautics, Ling-Temco-Vought, has theorized what expected exposure might do to man in single-wall vehicles.

The group, led by Life Sciences chief Dr. Charles F. Gell and Allen B. Thompson, conducted a series of tests in a hypervelocity test facility.

Particles were accelerated by a special charge to hypervelocities in a vacuum, and impacted into a number of vessels containing various atmospheric mixtures. The penetration wall was 0.70-in.-thick aluminum, and the impacting particles were 2S aluminum

varying from 10 microns to approximately 2 millimeters in diameter. They were excited to velocities on the order of 8 km/sec. for the larger particles and 20 km/sec. for the very small particles.

The Vought group indicated that the possibility of encountering a meteoroid of sufficient size to cause explosive decompression is so remote that it can be ignored. However, it found that there were unique effects of hypervelocity penetration of pressurized crew com-

partments which considerably increased crew hazard.

• **What happens** — When the particles strike the wall, the impact produces a very high heat which melts and/or vaporizes the impacting particle and the wall around it. This of course produces a crater or hole in the wall.

If the crater penetrates the vehicle wall, the remains of the particle and the surrounding material, now in partially-melted or vaporized form, enters the chamber and a very rapid, almost explosive oxidation occurs. This produces an intense flash of light, which might last for a period of .8 to 1.2 milliseconds.

In the tests, open-shutter photographs were taken inside the chamber through a Mylar filter having a transmissibility of approximately 0.1%.

In a chamber with standard, sea-level atmospheric conditions, the flash reached a peak intensity of over 3 million lumens. Significantly, in a 100% O<sub>2</sub>, 5 psia atmosphere (with which U.S. space vehicles are designed to operate) the intensity was over 20 million lumens. The group points out that a GE No. 5 flashbulb reaches a peak of 1.2 million lumens. And the temperature one inch to the side of the flash was greater than 1500°F.

• **Casualties**—Animals in the two chambers dramatically illustrated the different degrees of reaction occurring in the two chambers.



*SIMULATED* human tissue shows effect of super-heated fluids' vaporization.



In the sea-level chamber, white rats survived the flash and heat of the explosion, but suffered superficial injuries. These ranged from burns from spilled wall material to one or two broken backs from the blast wave. Gell pointed out that had they been human, they probably would have had reduced performance capabilities, since they evidenced some symptoms of shock and possible diminution in visual ability.

Animals in the 100% O<sub>2</sub> atmosphere died instantly from blast and burns resulting from a catastrophic atmospheric flash lasting one millisecond.

The factors which apparently determine the degree of explosion and resulting injury are:

- Cubic volume of the cell.
- The total atmospheric pressure and partial pressure of O<sub>2</sub> in the cell.
- Rate of decompression.
- Ignition temperature generated by projectile and wall vaporization.
- Total amount of combustible material in the test cell.

Particles were fired into sponge-like material simulating human material (shown in photo) with startling results. Violent rupture of the material occurred, and pressure suits could not protect against this.

• **Effect on crew**—Thompson and Gell conclude that these things are likely to occur upon meteoroid penetration of crew compartments:

- Decompression will obviously occur unless the atmosphere is replaced at a rate in excess of the leak rate.
- The flash of vaporous wall material and the meteoroid upon hypervelocity impact may temporarily blind the crew. This in turn might delay repair of the damage, with further complications.

—Local burns of severe nature would result if a crew member were in close proximity to the wall at point of penetration.

—Material spilled off the inner cabin wall ahead of the penetration may produce puncture damage to crew members much in the manner of a shaped-charge penetration of military tank vehicles.

—The atmospheric oxygen will be used in oxidation of the wall material and meteoroid and could catastrophically "flash" and be consumed.

Metallic hard-shell type suits are suggested as only minimum protection. Other suggestions are that vehicle walls be constructed of multiple thickness (M/R, Nov. 6, p. 32) with a standoff distance of at least one inch between the walls. This space might contain vacuum or a very-low-density solid such as a glass wool or foamed magnesium.

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### SYSTEMS ANALYSTS

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### SENIOR PHYSICISTS

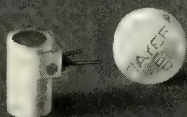
These positions involve conducting investigations in weapon and space environment, radiation effects, plasma dynamics, weapon effects, geo-space physics and planning, and operating shot tubes. A degree in Electronics or Physics is required, along with substantial applicable experience.

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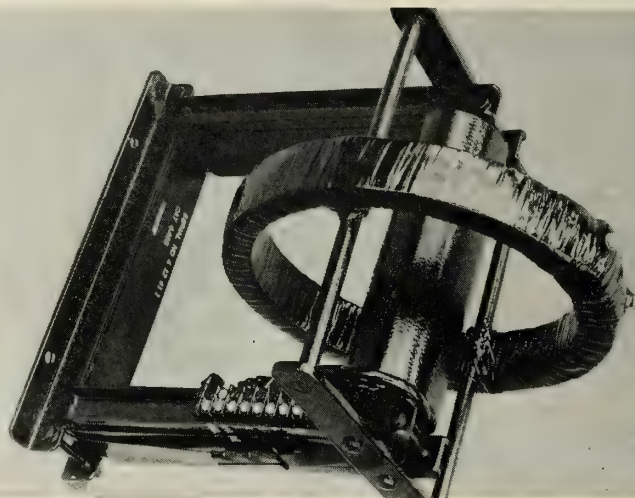
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44

Circle No. 12 on Subscriber Service Card



## New Product of the Week:

### High-Voltage Isolation Transformer

A LINE of high-voltage, low-capacity isolation transformers is available from Radiation at Stanford, a subsidiary of Radiation, Inc.

Available in standard ratings up to 6000 volt-amperes output, the transformers are suited for operation at working voltages up to 55 kv in air, or 100 kv when oil-immersed. They can be supplied at any specified primary and secondary voltage up to 600 volts. The transformers exhibit very low secondary-to-primary and frame capacitance in the order of 25 to 35 picofarads. Current limiting can be furnished.

Typical applications are for klystron, rectifier or diode filament supplies.

Circle No. 225 on Subscriber Service Card

## Compact Discriminators

Two compact telemetry discriminators used in interpreting information from composite radio signals sent from missiles and satellites in flight are available from Airpax Electronics, Inc. Both products, Models A-135 and A-136 contain more than 90 individual components including finely-built bandpass filters. These filters accept only a single channel from the composite signal from a missile or satellite for specific information interpretation. The two discriminator models differ in

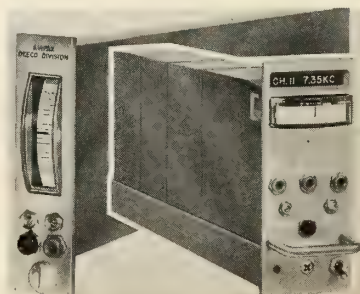
stability, linearity, input dynamic range and output, but have similar center frequency range characteristics. These include all standard I.R.I.G. channels, with other channels available from the manufacturer on special order.

Circle No. 226 on Subscriber Service Card

## Explosive Cartridges

The Hi-Shear Corp. is manufacturing a family of explosive cartridges. These standard units provide power to actuate mechanisms such as separation systems, thrust reversal and termination systems, electrical disconnects, parachute and data package ejection systems and other cartridge actuated devices. Hi-Shear power cartridges have been developed with design parameters which meet all pertinent military specifications and are environmentally qualified.

Circle No. 227 on Subscriber Service Card



## Temperature Transducer

A high-accuracy high-speed-response temperature transducer is available from Temtro, Inc., for applications

missiles and rockets, November 20, 1961

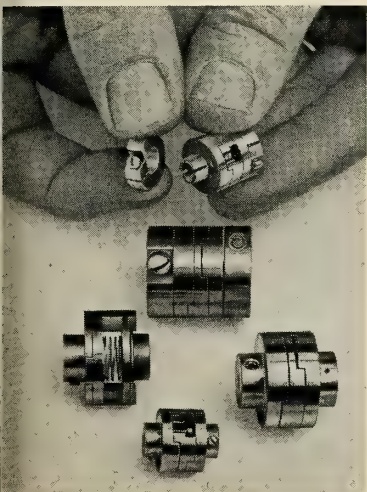


where space, weight, and thermal mass are so critical there is no room for a conventional sensing device. Guaranteed accurate to 0.1% of full range from  $-425^{\circ}\text{F}$  to  $1750^{\circ}\text{F}$ , the "peanut" transducer, with integral one-piece stainless steel construction, is highly resistant to thermal and physical shock. Linearity is high, hysteresis almost non-existent. The unit is designed to operate in almost any environment, and in most corrosive, conductive or contaminated solid, fluids or gases. Response time is less than 100 ms for 90% of final reading.

Circle No. 228 on Subscriber Service Card

## Oldham Couplings

Dynamic Gear Co., Inc., has available a line of Oldham Couplings from stock. Manufactured to the most precise tolerances currently available in the gear industry, the couplings permit axial misalignment of shafts which are as much as 1/32 of an inch out of align-

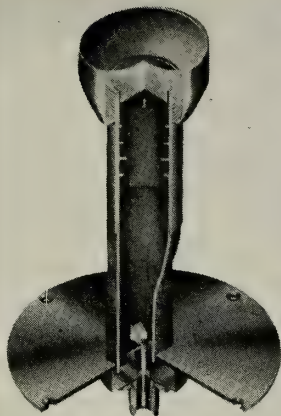


ment. The units feature a backlash tolerance of 8 minutes of arc. The units are available in more than 60 different combinations of clamp type and solid type hubs, and can be used to couple different size shafts, ranging from 0.125 to 0.250 in diameter.

Circle No. 229 on Subscriber Service Card

## X-Band Lens Antenna

The Model ALXN-1A, an X-Bank Lens Antenna which radiates a circular polarization with a hemispherical radiation coverage, is available from Canoga Electronics Corps. Two lens antennas properly installed on an airborne vehicle afford complete tracking coverage for any yaw, pitch or roll aspect. The antenna consists of a type N connector, a coaxial-to-rectangular waveguide transition, a taper section



from rectangular-to-circular waveguide, a section of circular waveguide containing a six-pin circular polarizer and four orthogonally placed matching posts. The circular waveguide is terminated in a dielectric lens. The lens broadens the beam to provide more nearly isotropic radiation over the hemisphere.

Circle No. 230 on Subscriber Service Card

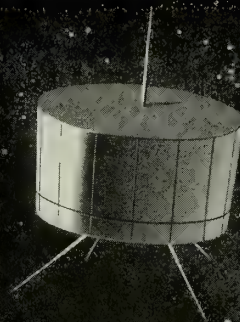
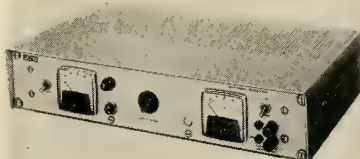
## Air Bearings

Air bearings for satellite simulators, consisting of spheres and matched seats and sockets, are available from Industrial Tectonics, Inc., Sphericity of bearings up to 12-in. in diameter can be held to 0.000050 in. or less with surface finish of 4 microinch or less. Other tolerances can be held consistent with requirements of matching the sphere to bearing socket. The firm can make any practical size bearings and sockets to specifications.

Circle No. 231 on Subscriber Service Card

## Frequency Changer

A new 400-cycle sine wave frequency changer able to maintain  $\pm 0.25\%$  frequency over maximum line and load change, is available from Magnetic Research Corp., Hawthorne, Calif. The solid-state 100-VA converted is packaged for bench or rack-mounted applications and is designed for laboratory, production-testing and ground-power installation. Regulation of the adjustable 105- to 130-volt single phase output is  $\pm 1\%$  from full load, or



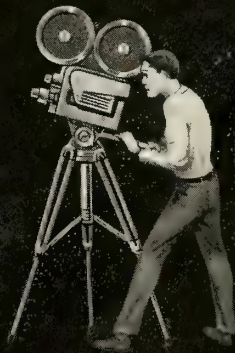
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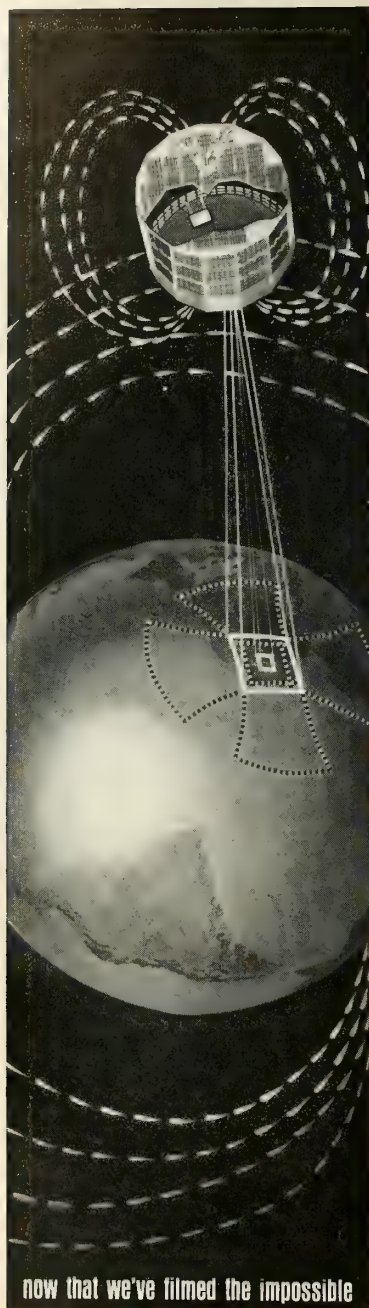
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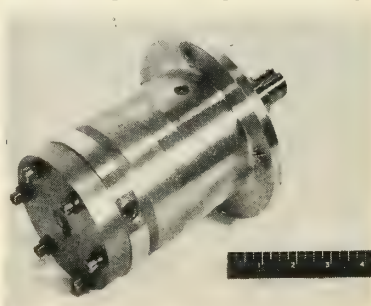
### Cu/Epoxy/Glass Laminate

A copper-clad epoxy-glass laminate which exhibits superior stability at high solder temperatures is available from General Electric's Laminated Products Department. The NEMA G-10 grade, designated Textolite 11578, has completed field evaluation with no evidence of "measling" or "hold tilting". Grade 11578 has outstanding machineability and meets the requirements of MIL-P-18177C, Type GEE, and MIL-P-13949B, Type GE. It is an improvement over G.E.'s grade 11558 and will replace it.

Circle No. 233 on Subscriber Service Card

### Peroxide Pumps

A series of pumps designed for handling  $H_2O_2$  and other liquid monopropellants and fuels is available from Clevite Ordnance, division of Clevite Corp. The series provides delivery rates ranging from 0.1 gpm to 20 gpm, at pressures up to 3000 psi. The design

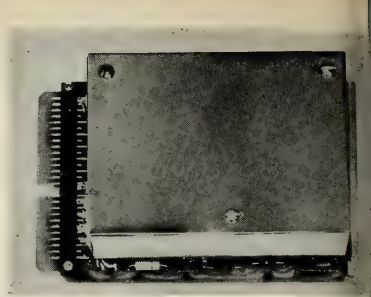


is a multicylinder swashplate, with a common driven valve. Pumps range displacement from 0.2 to 1 cu. in. They are suitable for service at up to 6000 rpm, and range from 6 to  $7\frac{1}{2}$  in. long and from  $3\frac{1}{2}$  to  $5\frac{1}{2}$  in. in diameter. Weights range from 6 to 30 lbs.

Circle No. 234 on Subscriber Service Card

### Computer Control

A digital serial memory with pulse delays ranging from 20  $\mu$ sec to 100  $\mu$ sec at operating frequencies of 8 to 16 mc is available in a compact, self-contained plug-in package from Computer Control. Designated the SM-40, this unit provides storage at unprecedented data input rates, as high as 16 megabits per second, without the need for carrier modulation. The SM-40 package contains all necessary input-output logic and is fully compatible with existing



Computer Control Company H-PAC digital modules for the implementation of complete serial memory systems.

Circle No. 235 on Subscriber Service Card

### Furnace Atmosphere Control

An instrument that automatically controls the carbon potentials of furnace atmospheres is available from Lindberg Engineering Co. The Infrared Carbontrol is a dual-range unit with automatic range switching. The two ranges are 0-0.2% and  $CO_2$  and 0-1.0%  $CO_2$ . Calibrating gases are conveniently located within the control panel. The unit can be used for atmosphere control for carburizing, neutral hardening and carbon restoration and can be used with any dew point gas. It is not affected by gases such as ammonia.

Circle No. 236 on Subscriber Service Card

### Universal Joints

A line of heavy-duty industrial universal joints designed to provide high horsepower capacity at speeds up to 1750 rpm. is now available from Lovejoy Flexible Coupling Co. Single joints provide smooth, sensitive operation through a full working angle of  $40^\circ$  double joints through  $80^\circ$ . Rated at 0.41 to 150 hp. at 100 rpm., in a size range from  $\frac{3}{8}$  in. to 3 in., they are available either solid or bored. Bored other than standard are available, including square holes.

Circle No. 237 on Subscriber Service Card

### High-Pressure Transducer

The Instrument Division of DeJure-Amsco Corp. has available a transducer providing a potentiometric output with wide pressure-range coverage. Designated Series HPT-10, this reliable, precision mechanism features simple and economical design, and can withstand critical military and commercial environments including operating temperatures of  $-55^\circ C$  to  $+100^\circ C$ , and measurement of corrosive and non-corrosive media. Full-scale range is 0-100 psia or psig to 0-10,000 psia or psig with a static accuracy band of  $\pm 1.5\%$  or better available on most pressure ranges. Resolution is 0.22% to 0.33%.

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# contracts

## AIR FORCE

- \$35,791,240—The Boeing Co., for production of *Minuteman* missiles, operational and training equipment and other components related to the system.
- \$35,430,000—General Dynamics/Astronautics, San Diego, for boosters for a number of classified programs.
- \$13,432,379—The Boeing Co., for research and development for *Minuteman* missile.
- \$10,036,224—North American Aviation, for research and development of *Minuteman* guidance and control.
- \$8,920,000—General Electric Co., Philadelphia, for development of a re-entry vehicle for the *Titan II* missile.

- \$7,568,760—The American Machine and Foundry Co., for installation and checkout of ground support equipment for *Titan* missile operational sites at Lowry AFB, Colo.
- \$5,482,500—Avco-Everett Research Laboratory, Everett, Mass., for basic research in re-entry physics.
- \$4,442,000—The Boeing Co., Seattle, for engineering planning, field assembly and checkout of *Minuteman* missile at Vandenberg AFB, and for *Minuteman* assembly and checkout at Minot AFB, N.D. (2 contracts).

- \$4,075,731—Radio Corp. of America, for provision of initial spares and ground support equipment for Ballistic Missiles Early Warning System (BMEWS).

- \$2,400,000—The Rand Corp., Santa Monica, Calif., for aerospace power research.

- \$2,150,000—Lockheed Missiles and Space Co., Sunnyvale, Calif., for production of *Agenda* space vehicles.

- \$1,882,674—North American Aviation, Los Angeles, for production of pylons and and spare parts for *Hound Dog* missiles for B-52 aircraft.

- \$1,600,000—Hughes Aircraft Co., for production of *Falcon* weapon system evaluation, missiles and spares and for work on *GAR-1D* and *GAR-3A*.

- \$1,089,999—Columbia University, New York City, for Project *Defender* studies.

- \$996,316—Ampex Data Products Co., Atlanta, for wideband tape recorder/reproducer.

- \$367,467—Boston College, Chestnut Hill, Mass., for research directed toward the analysis of impedance probe data in missile trails; Thompson Ramo Wooldridge, Los Angeles, for System 473L communications and processing equipment (2 contracts).

- \$267,400—BOA Corp., Anaheim, Calif., for addition to data acquisition and processing building, Vandenberg AFB.

- \$184,249—Texas Instruments, Inc., Dallas, for continuation of research on "on-site geochemical and gamma ray spectral measurements—Project *VELA*."

- \$99,727—Cornell Aeronautical Lab., Inc., Buffalo, for continuation of research on molecular interactions at high temperatures.

- \$90,000—Massachusetts Institute of Technology, Cambridge, for study of plane shocks and high-speed plasma in magnetic fields.

## ARMY

- \$9,000,000—Radio Corp. of America, Camden, N.J., for radio sets, including micro-module version of AN/PRC-25.

- \$7,852,000—Morrison-Knudsen Co. Inc. and Paul Hardeman, Inc., Los Angeles (joint venture), for missile launch facilities,

*Titan II*, Phase IIA, near Little Rock AFB, Ark.

- \$7,060,200—The Fluor Corp., Los Angeles, for construction of missile launch facilities for *Titan II*, Phase IIA near Davis-Monthan AF Base, Tucson, Ariz.

- \$6,460,650—Martin K. Eby Construction Co., Inc. & Associates, Wichita, Kan., for construction of Missile Launch Facility, *Titan II*, Phase IIA near McConnell AFB.

- \$98,700—Western Electric Co., Inc., New York City, for *Nike* repair parts (2 contracts).

- \$40,450—C. L. Linfoot Co., East Grand Forks, Minn., for construction of SAC missile facility alterations. Grand Fork AFB, N.D.

## MISCELLANEOUS

- \$4,600,000—Space Technology Laboratories, subcontract from Sanders Associates, Nashua, N. H., for production of broadband power amplifiers.

- \$1,500,000—Beckman Instruments, Inc., Fullerton, Calif., from North American Aviation, Inc., for electronic units to be used in the automatic checkout system of the AF *Minuteman* ballistic missile (2 contracts).

- \$50,000—McCormick Selph Associates, Hollister, Calif., from Douglas Aircraft Co., Inc., for design and development of an explosive detonator cartridge to be used in connection with a missile-stage destruct system on S-IV of NASA's *Saturn* launch vehicle.

## NASA

- \$165,000—Electronic Associates, Inc., Long Branch, N.J., for centrifuge problem computer, services and materials necessary for fabrication and delivery.

- \$85,930—Vitro Engineering Co., div. Vitro Corp. of America, New York, for study of requirements for nuclear rocket engine maintenance and disassembly building.

- \$83,020—Tinius Olsen Testing Machine Co., Willow Grove, Pa., for testing machine suitable for tension, compression and transverse loading for Lewis Research Center, Cleveland.

- \$59,942—Geophysics Corp. of America, Bedford, Mass., for study of the meteorology of Mars and Venus.

## NAVY

- \$8,100,000—Westinghouse Electric Corp., Sunnyvale, for design, development and fabrication of *Polaris* launchers.

- \$5,000,000—Goodyear Aircraft Corp., for research and development on *SUBROC* missile system.

- \$5,000,000—General Electric Co., Pittsfield, Mass., for fabrication of fire control units for *Polaris* missiles.

- \$3,000,000—Radio Corp. of America, for final-stage development of devices and techniques for an ultra-swift computer the size of a portable television set.

- \$266,000—B. F. Goodrich Aerospace and Defense Products, Los Angeles, for production of solid-fuel motors for the *Loki* atmospheric sounding rocket.

- \$103,090—Skagit Steel and Iron Works, Sedro-Wooley, Wash., for missile handling equipment for underway replenishment (FAST) consisting of structure machinery and controls.

- \$27,722—Materials Research Corp., Yonkers, N.Y., for conducting a program in thin films as applied to thermoelectric power.

Questions  
and  
Answers  
about the

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**Gen. John M. Schweizer, Jr. (USAF-Ret.):** Named to direct the West Coast marketing operation for Textron's Bell Aerosystems Company. Schweizer, a command pilot, served with Air Force Intelligence from 1948 to 1958, retired in 1959 and has been with Bell since then as European Representative.

**John L. Loeb, Jr.:** Elected a director, Adler Electronics Inc., New Rochelle, N.Y.

**Rolf D. Weglein:** Appointed head of product development, Hughes Aircraft Co.'s microwave tube division, Los Angeles.

**Kraft A. Ehricke:** Noted space authority and program director for Project Centaur at General Dynamics/Astronautics, presented the G. Edward Pendray Award by the American Rocket Society at its 16th Annual Meeting held recently in New York City. The award was given to Dr. Ehricke for his outstanding contributions to literature in rockets and astronautics. His latest work is a three-volume treatise entitled "Space Flight."

**Col. Milton L. Rosen, U.S. Army, (Ret.):** Appointed director of Projects Development, Harvey Aluminum, Inc. Col. Rosen, who retired from the Army in 1955 after twenty years' commissioned service, was active in the industrial field before accepting his new position with Harvey.

**S. E. Weaver:** Appointed vice president of engineering and marketing, the Marquardt Corporation. Mr. Weaver will have cognizance over the company-sponsored research and development program, product reliability, quality control, and tool engineering and control. He will also be responsible for corporate market research and product evaluation and assignment.

**Ben L. Williams, Jr.:** Named to fill the newly-created position of corporate director, information, for the Fairchild Stratos Corp., responsible for all elements of the company's information program including news, print material, stockholder communications, and advertising. He was formerly director of public relations for the York Division of Borg-Warner Corp., manager

of public relations of VanSant, Dugdale and Co., and a member of the public relations department of J. Walter Thompson Co.

**Stanley M. Handelman:** Elected chairman of the board of Theta Instrument Corp. He is the company's secretary-treasurer and was one of the founders in 1956.

**Dr. Andrew O. Jensen:** A leading authority in the field of thermionics, has been named to head the newly established Energy Conversion Department in the Advanced Power Systems Division of Electro-Optical Systems, Inc., Pasadena, Calif. He will direct the department's activity in areas of thermionics, thermoelectrics, solar cells, and research leading to their integration into complete power packages for space vehicles and auxiliary ground power unit applications.

**John W. Downs:** Appointed general manager of the newly created corporate division, Radiation at Orlando, of Radiation, Inc. This division combines the existing Orlando Systems Development and Manufacturing Divisions. Downs joined the company in 1955 as a section head, progressed through various positions, was director of major programs including *Minuteman* and *Titan* telemetry contracts, and served as director of corporate planning on the president's staff.

**Harry H. Gorman:** Appointed to the position of deputy director for administration at the Marshall Space Flight Center, Huntsville, Ala. He has been with NASA at Marshall since June, 1960. Before coming to Marshall, he was with the AEC for 10 years.

**Samuel B. Fishbein:** Appointed director of military programs for the Capehart Corp., Richmond Hill, N.Y., with responsibility for systems engineering and project control and liaison. Prior to joining Capehart, Fishbein was associated with the International Electric Corp., the A. B. Dumont Laboratories, the American Machine and Foundry Co. and the Rome, N.Y., Air Development Center.

**Harold Shnitkin:** Appointed head of advanced research and development, An-

tenna Division, Avien, Inc. Shnitkin, with Avien since July, will be responsible for research and development of complex phased-array designs of the Avien-Bogner disc-on-rod antenna systems. A considerable portion of his work will be devoted to application of digital computer techniques to the solution of antenna array problems. Previously he was associated with the W. L. Maxson Corp. and with Fairchild Guided Missile and Airborne Instrument Laboratory, Inc.

**Nathaniel Hughes:** Elected president of the newly formed Sonic Development Corporation of America. Hughes, formerly with General Precision's Kearfott Division, was also previously associated with Lear, Inc. and Reaction Motors in product development and marketing capacities.

**Joseph Oppenheim:** Promoted to the newly created post of director of programs management for Raytheon Company's Electronic Components and Devices Group. Oppenheim joined Raytheon in 1942 as a radar development engineer and progressed through various posts to the position of programs manager for the Aero/Weapons division, and thence to his present position.

**John K. Levin:** Appointed vice president in charge of manufacturing by Power Designs Inc., Westbury, L. I., N.Y. He will continue as plant manager. Prior to joining Power Designs, he was associated with the Semiconductor Division of the Sperry Corp., the Aerovox Corp., thesylvania Electric Products Corp., and Radio Corporation of America.

**Perry R. Roehm:** Executive vice president of the Barden Corporation, has been elected a director of the company. Roehm has been with Barden for more than 10 years, holding a number of management positions.

**Robert M. Gitlin:** Appointed vice president and general manager of a new Univis, Inc. subsidiary, American Aerospace Controls, Inc., Farmingdale, N.Y. Gitlin was formerly associated with Fairchild Controls Corporation, Servomechanisms, Inc., and the Kollsman Instrument Corporation.



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## when and where

### NOVEMBER

**ASME Winter Annual Meeting**, Statler Hilton Hotel, New York City, Nov. 26-Dec. 1.

### DECEMBER

**Annual International Visual Communication Congress**, cosponsored by Society of Reproduction Engineers, American Institute for Design and Drafting and the American Records Management Association, Biltmore Hotel, Los Angeles, Dec. 2-5.

**National Aerospace Support and Operations Meeting**, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Fla., Dec. 4-6.

**19th Annual Electric Furnace Conference**, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.

**Eastern Joint Computer Conference**, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C., Dec. 12-14.

**Annual Meeting**, American Association for Advancement of Science, Denver, Dec. 26-31.

**Annual Meeting**, American Statistical Association, Roosevelt Hotel, New York City, Dec. 27-30.

### JANUARY

**8th National Symposium on Reliability and Quality Control**, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

**National Plant Engineering and Maintenance Show and Conference**, Convention Hall, Philadelphia, Jan. 22-25.

**Solid Propellant Rocket Conference**, ARS, Baylor University, Waco, Tex., Jan. 24-25.

### FEBRUARY

**Western Electronic Week and Pacific Electronic Trade Show**, Las Vegas and Los Angeles, Feb. 3-11.

**Winter Convention on Military Electronics**, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

**International Solid State Circuits Conference**, Philadelphia, Feb. 14-16.

**30th Annual Symposium on Nondestructive Testing of Aircraft and Missile Components** (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

### MARCH

**5th Annual Technical Conference**, Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

**Armed Forces Communications and Electronics Association**, Cape Canaveral Chapter, symposium to be held in Cocoa Beach, March 6-8.

**1962 Symposium on Packaging of Chemi-**

**cal Products**, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, March 13-14.

**Electrical Propulsion Conference**, ARS, Hotel Claremont, Berkeley, Calif., March 14-16.

### APRIL

**Launch Vehicles: Structures and Materials Conference**, ARS, Ramada Inn, Phoenix, Ariz., April 3-5.

**13th Annual Advanced Statistical Quality Control Institute**, University of Connecticut, Storrs, April 8-20.

**Institute of Environmental Sciences Annual Technical Meeting and Equipment Exposition**, Sheraton Towers Hotel, Chicago, April 11-13.

**Second Conference on Kinetics, Equilibria, and Performance of High-Temperature Systems**, Western States Section of the Combustion Institute, University of California, Los Angeles, April 14-16.

**American Society for Metals Regional Conference and Exhibition**, Materials and Materials Processing for the Petroleum, Petrochemical and Chemical Industries, Shamrock Hilton Hotel, Houston, April 17-19.

**Western Space Age Industries and Engineering Exposition and Conferences**, Cow Palace, San Francisco, April 25-29.

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# A New Look in Procurement

**P**RESIDENT KENNEDY, writing in *MISSILES AND ROCKETS* magazine last year prior to his election, promised a thorough reorganization of the Department of Defense and a streamlining of defense regulations and procedures.

Now, more than a year after the election, it is perhaps time to review what the new Administration has accomplished in this field, particularly in regard to the area of most immediate concern to the missile/space industry—procurement.

Hacking away at the maze of bureaucratic red-tape and long-entrenched Pentagon procedures is not an easy task. It is impressive, therefore, that the President and Defense Secretary McNamara have made considerable progress in updating Pentagon procurement practices.

We are particularly pleased with the top-level recognition that the industry is entitled to a fair margin of profit and that a job exceptionally well done deserves exceptional rewards. It goes without saying that the reverse, penalties for poor performance, must be equally acceptable to the industry.

Just how far the Administration is prepared to go in this direction was made clear in a New York speech earlier this month by Joseph S. Imirie, Air Force assistant secretary for materiel.

"We will consider proposals for profit levels that exceed the administrative limitations all the way up to the 15% statutory limitations," he said. "But you can be sure we will do so only when the contractor's performance far exceeds predetermined standards."

This 15% limit applies to research and development contracts; the limit is 10% on production contracts.

Assistant Secretary Imirie said the Air Force will make increasing use of incentive provisions based on reliability, performance and time of operational readiness of new systems.

"We fully recognize the fact that cost reduction is only one of several benefits that can stem from good contract performance—and we are willing to reward the companies that come up with truly useful, extraordinary results," he said. "By the same token, there will have to be commensurate penalties for mediocrity—whether costing, time of delivery, reliability of hardware or system performance."

The new policy is a sharp and welcome departure from previous practice limiting profits to a maximum of about 9% on cost-plus-incentive-fee contracts with similar restrictions on fixed price-incentive contracts. It has been under development since first outlined to industry at the June meeting of the National Security Industrial Association by Secretary McNamara and Assistant Defense Secretary Thomas D. Morris.

It became official practice in August when Maj. Gen. William T. Thurman, director of Air Force

procurement management, advised the Air Force Systems Command and Air Force Logistics Command that his headquarters would favorably consider requests to exceed Armed Services Procurement Regulations limitations on fees.

It also is welcome news that the Air Force is not stopping there.

Gen. Thurman's directorate has established an office known as the Procurement Policy Development Branch. It is seeking industry help.

This office is, in effect, carrying out research and development on procurement practices. It will be divorced from day-to-day contracting problems. Its objectives are outlined by Lt. Gen. Mark E. Bradley, Jr., USAF deputy chief of staff for systems and logistics, in the current issue of the official Aerospace Industries Association publication. He states:

"We must have clearer statements of requirements, simpler specifications and more clearly stated performance goals. We must take a closer look at the types of contracts we use. We intend to do more in the area of evaluating proposals within the boundaries of how much defense, at what price, and in what time span. We will show an increasing concern for the time given to development. We will insist on getting reliable cost estimates. And we will continue to recognize the rights of industry to fair, earned profit."

**T**HESE, SURELY, are all goals with which the industry can agree.

"The main point is that we want some new approaches," Gen. Bradley emphasizes. He says the office already is at work on incentives, penalties, cost estimates and profits. It also will go into the areas of procurement of critical and non-critical spares, sole-source versus competition, proprietary interests and contractor proposals.

"We fully realize that what we are trying to do is pretty new in the Air Force procurement field," the general says. "We also realize that we do not have and cannot get all the answers to our questions strictly within the Air Force. For this reason, we are asking industry to cooperate with us to the fullest extent. We must have ideas and proposals on the subject from our suppliers—otherwise, we cannot develop the kind of procurement policies that will be equally fair to them and to us."

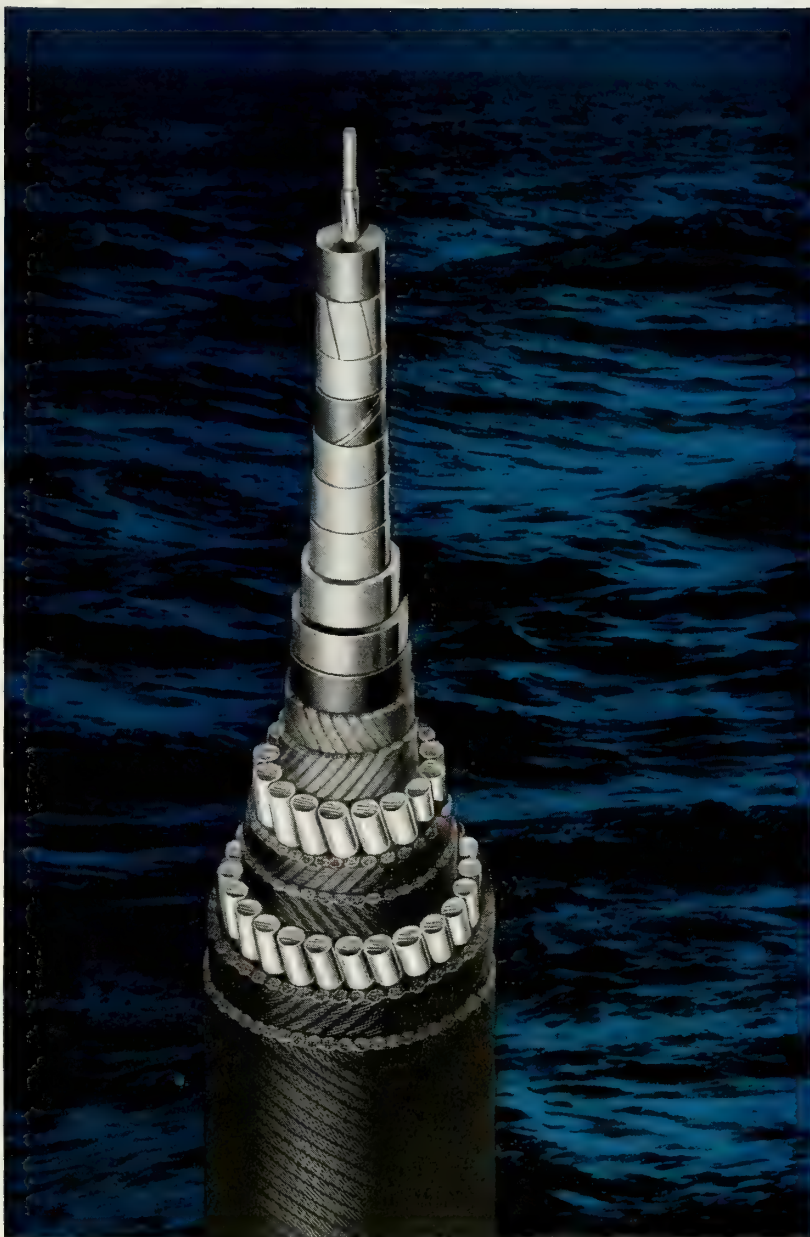
President Kennedy has gone a long way in his first year in office toward making good on author Kennedy's promise. The industry now has an opportunity to help the Administration go even further. It should respond wholeheartedly to the appeal from Gen. Bradley.

**William J. Coughlin**



# Submarine Cables for Communications, Control & Power

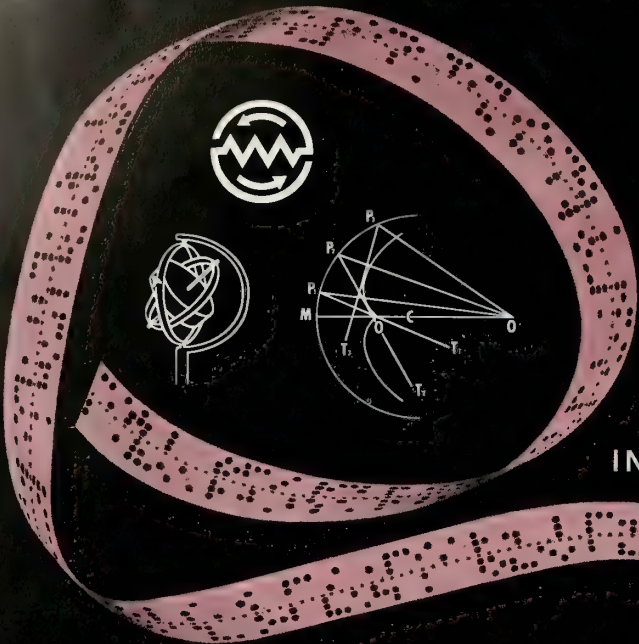
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- Radiometric and Spectral Analysis



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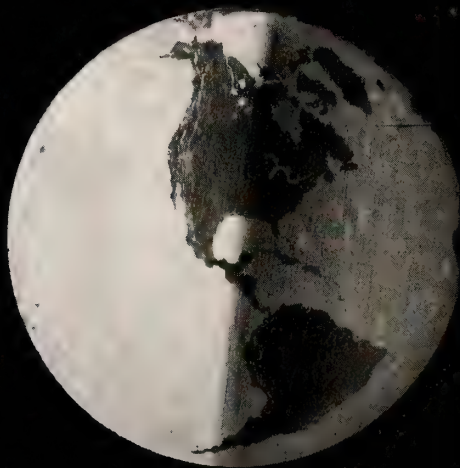
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North American Begins Work on Apollo . . 15

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propellers represents a large continuing part of the division's production.

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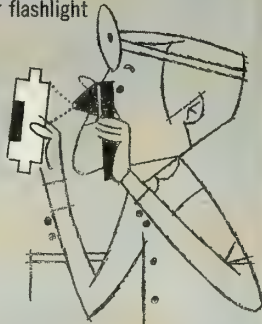
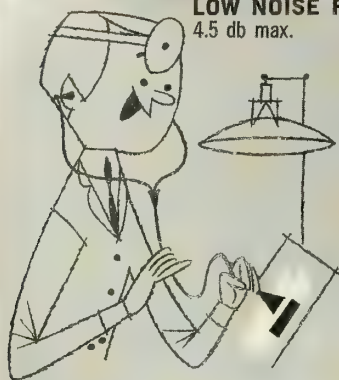
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## Dissecting Gilpatric

To The Editor:

Mr. James Baar's "dissection" of Deputy Defense Secretary Roswell L. Gilpatric's round-up of our defense posture ("Kennedy War Deterrent Remains Marginal," M/R, Oct. 30, p. 12), presents a few inaccuracies of its own.

Dissection of the dissection:

1. "The Russians have long been credited with a sufficient stockpile of IRBM's and MRBM's to wipe this entire force (our *Thors*, *Jupiters*, *Matadors*, *Maces*, fighter-bombers and medium bombers deployed around the Soviet periphery) from the board in a first strike."

This is a sweeping exaggeration of the operational capabilities of the Soviet missile command. Admittedly the *Thors* as presently sited, are sitting ducks; the *Jupiters* have better, but not ideal protection. *Maces* and *Matadors*, however, have some ground mobility; and of the fighter-bombers and medium bombers, under existing alert procedures, no Soviet planner could possibly be sure of catching even 50% on the ground in a surprise first strike.

The principle to be kept in mind is that of *deterrence*, and deterrence starts with *enemy* calculations of risk against advantage. What *might* happen if he had 100% good luck is of little importance. What counts is what he can reasonably expect to do, considered in terms of what certainly will happen to him if his expectations are not fulfilled. No coordinated missile strike of the magnitude required for this purpose has even taken place: the operational problems are enormous, quite aside from questions as to the reliability and accuracy of weapons. That Soviet planners could confidently count on more than a fractional success in such an effort is incredible.

2. "As for the attack carriers, there are five deployed in advance positions from which a retaliatory blow... could be mounted. However, whether the carriers in advance positions would survive the initial attack is debatable."

The overall number of operational attack carriers is being increased from 14 to 16. The total number deployed at any given time in the Mediterranean (6th fleet) plus the Western Pacific (7th fleet) may vary from five to seven. However, the 2nd Fleet in the North Atlantic is nearing the status of a deployed fleet. Since any coordinated first strike would require thorough advance planning and a selected strike-day, Soviet planners could not safely assume that at this preselected moment less than eight to ten carriers would be capable of prompt retaliation. Nor could they count, within limits of their capabilities, on destroying or damaging even one carrier before her retaliatory strikes had taken off.

3. "Only five (not six) *Polaris* submarines carrying a total of 80 missiles

(Continued on page 6)

missiles and rockets, December 4, 1961



# missiles and rockets

Volume 9, Number 23

December 4, 1961

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## THE COVER

*Huge antenna to be installed at last of three BMEWS stations, in England. BMEWS is key part of U.S. command/control system, which may be drastically reorganized. See p. 12.*



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\*U.S. Reg.

†U.S. Reg. Pdg.

37,862 copies this issue

## Letters

(Continued from page 4)

have been deployed to date".

True, but this is nit-picking. The sixth submarine (*Ethan Allen*) is running her sea trials; three more of her class will be in commission early next year. Also, the *Polaris-B* missile with increased range will be coming into service.

Thus at least 500 fighter-bombers and medium bombers, three to five attack carriers and a substantial extra margin of *Polaris* capability must be added to Mr. Baar's estimate of the U.S. deterrent force which the Soviet must assume will survive a first strike.

As to the future, Soviet long-range planners must face the certainty of a steady increase in our *Polaris* fleet, to which they have developed (so far) no adequate countermeasures and will be even less able to do so as the range of the missile increases. I regret the decision not to continue B-52 production, which seems to me to be premature; but on balance I cannot agree with Mr. Baar that we are not making adequate provision to maintain a "clearly dominant military position" as far as our nuclear deterrent force is concerned. Continued superiority in that vital task must, in my view, depend chiefly on mobile rather than fixed-site weapons.

With Mr. Baar's contention that we are not doing enough "for the development of military offensive and defensive space systems"—as reflected in the guide lines for the Fiscal Year '63 budget—I certainly do agree. I wish he had made a more convincing argument on this point, and perhaps for more steam behind the antimissile program, for a comprehensive and urgent approach to antisubmarine warfare, and for manpower levels for all the services that would be reasonably adequate to meet our rising global responsibilities. It is in these areas—space included—that it seems to me Secretary Gilpatric glossed over our shortcomings, rather than in the nuclear deterrent field.

GEORGE FIELDING ELIOT  
New York City

## A Reply

Mr. Eliot, the eminent writer on military affairs, has raised some very important points.

A dissection of Mr. Eliot's dissection: He says,

1. "No Soviet military planner could possibly be sure of catching even 50% (of the Free World land-based strategic forces overseas) on the ground in a surprise attack."

On the other hand no U.S. military planner can be sure that the Russians would not be able to catch 80 to 90 per cent. For some time, U.S. military planners have credited the Russians with having these forces outgunned. No one can be certain how effective a surprise attack on these forces would be. But, as Mr. Eliot correctly notes, deterrence "starts with enemy calculations"—what the enemy believes is credible. And missile experts generally estimate that Soviet confidence

in the reliability of the Red Army's long-tested IRBM's and MRBM's is quite high.

Moreover, Mr. Eliot did not mention the attrition factor. All of the Free World's land-based overseas forces except for the soft Thors and Jupiters are air-breathing and, therefore, even if they survived a surprise blow, they would have to run the Soviet air defenses. The carrier-based aircraft, of course, face the same tactical problem.

2. "... Soviet planners could not safely assume that ... less than eight to 10 carriers would be capable of prompt retaliation."

Mr. Eliot is in error. The United States today has only five attack carriers in deployed positions from which a strategic nuclear air strike could be mounted promptly. With luck, this force would be as large as seven if replacement carriers were arriving or departing at the time of the attack. All other U.S. carriers would be several to many days away from striking distance.

Mr. Eliot correctly notes that Soviet planners could not count on knocking out the carriers in advance positions before retaliatory strikes were launched. Nor, as the article pointed out, can U.S. planners count on the carriers not being knocked out.

3. Mr. Eliot says that it is "nit-picking" to note that five—not six—*Polaris* submarines are deployed. In considering the overall alignment of forces, he is correct. But the fact that Gilpatric erroneously said that six were deployed fitted the "good news" pattern of his address and was pointed up in the article for this reason.

As for Mr. Eliot's statement that "three more (*Polaris*) submarines will be in commission early next year," this is incorrect if by "in commission" he means deployed. The first of the three more submarines that he is talking about will be deployed in the spring; the last in the fall.

This last point is raised because for a number of years there has been a great tendency among many people in and out of the government—particularly in the government—to equate future plans with forces-in-being. For example, many statements are heard about the first Minutemen ICBM's being operational in mid-1962. This is roughly correct if the accent is put on the word "first." Actually, the first squadron is not expected to be deployed before the end of the year.

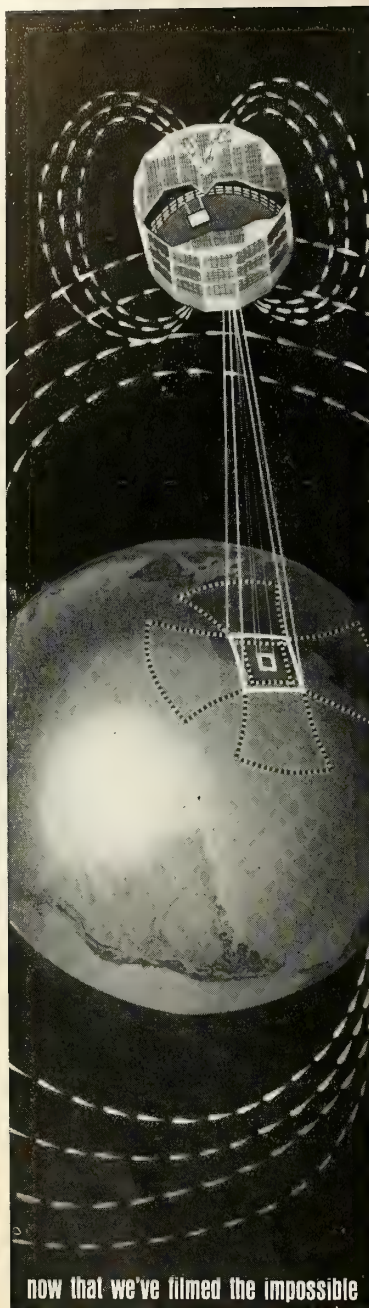
Regarding the need for much greater work on military offensive and defensive space systems and the strategic importance of deploying an antimissile missile system, the article did not expand on these points because they have been extensively covered in previous M/R stories.

In general, the question as to whether the United States is "making adequate provisions to maintain a 'clearly dominant military position,'" must be decided on two points:

—How credible does the United States want to make its deterrent force? Put another way, how narrow or how wide are the American people willing to have the margin of safety?

—Will America continue to be satisfied

missiles and rockets, December 4, 1961



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with a Cold War policy of trying to maintain a fine balance of nuclear terror in hopes that sooner or later Russia will "change?"

James Baar

## Shortage of Help?

To The Editor:

As a charter subscriber to your fine magazine, I have noted in it—and in other sources—a continuous demand for a greater space effort on the part of the U.S.: that our effort should be increased by 50% or some other figure.

I am heartily in accord with all this, but I have wondered for a long time if the technical help is available—or rather, can be made available—to carry out this increased effort. Our industrial effort is now—and probably will continue to be in the foreseeable future—primarily devoted to putting out consumers' goods; even so, a large part of our technical help is already engaged in defense work. Also, there is the well-known problem of technical education.

One has only to scan page after page of professional employment ads in such publications as *The New York Times* and the *Los Angeles Times* to be greatly impressed with the number of highly trained and experienced men needed for the present effort. Where would the help come from for a greatly increased effort?

The writer has never read a really good report on this vital matter. Perhaps your magazine can publish one, written by your staff or by an outsider—an authoritative treatise by someone who really knows the facts.

EMERSON W. CASE  
Fair Oaks, Calif.

## Non-Profit Brainpicking

To the Editor:

Regarding your Oct. 16 editorial "Enough of This Non-Profitteering," one can but wonder as to the history of the individuals who are employees of these organizations at one time or another.

The realistic situation which worries industry is that the broad need-to-know granted such organizations (and only a few years ago to a group in Melpar which was studying for the Air Force), gives the individuals license to pick brains all across the board.

With this reservoir of proprietary and company-confidential data, plus a lot of know-how generated from seeing how many companies work, make good decisions, and also make mistakes, the individual automatically becomes quite valuable to private industry—whether as an employee or as a person starting his own company.

We may even grant that 95% of all workers for the non-profits intend to and even will, stay with those organizations—for life. It's the potential 5% (and my numbers are probably quite conservative) who come around, pick our brains, and put out two together with somebody else's two to get a four-plus for themselves, and possibly employment with some competitor.

It would be interesting to run an em-

missiles and rockets, December 4, 1961



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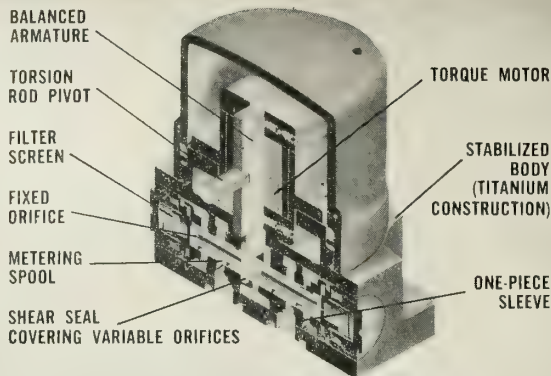
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| Hysteresis                   | 3% maximum total rated current                                             | 3% maximum total rated current                                                                                               |
| Supply pressure              | 300 to 3000 psi                                                            | 300 to 4000 psi                                                                                                              |
| Proof pressure               | 4500 psi pressure port<br>3000 psi return port                             | 6000 psi pressure port<br>3000 psi return port                                                                               |
| Pressure gain                | First stage—500 psi per ma minimum with 3000 psi supply<br>—65°F to +275°F | First stage—500 psi per ma minimum with 3000 psi supply<br>10,000 psi per ma minimum with 3000 psi supply<br>—65°F to +275°F |
| Load pressure gain           | 8500 psi per ma minimum with 3000 psi supply<br>—65°F to +275°F            |                                                                                                                              |
| Temperature                  |                                                                            |                                                                                                                              |
| Maximum Null Shift           | (% of rated current)                                                       | 1%                                                                                                                           |
| Temperature Change per 100°F | 1%                                                                         | 2%                                                                                                                           |
| Supply Pressure Variation ±  | 2%                                                                         | 1%                                                                                                                           |
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ployment profile of some of the former STL, Aerospace, MITRE, JPL, IDA, etc. executives and scientists.

We are actually not against non-profits. We know we can't solve the brain picking situation by doing away with them (for the civil servant, as an individual has the same capability). However we do question the propriety or desirability of broadening the scope of these rather anomalous types of extragovernmental brain factories—which must necessarily take their raw material either from within Government or from private industry. It would be interesting to see how many former employees went back into private industry after a tour with the non-profits.

Charles Kelchner  
Washington, D. C.

### Further Afterthoughts

To the Editor:

A hearty congratulation for your thought-provoking Nov. 6 editorial ("After thoughts of a Saturnalia").

Any contribution like yours toward informing the public about the present deadly situation is doubly useful in times like ours when political expediency seems predominant.

P. L. Bargellini  
Associate Professor  
of Electrical Engineering  
University of Pennsylvania  
Philadelphia

To the Editor:

Congratulations on the editorial. Things should work.

General Bernard Schriever's statement, "Space power is peace power," could well be adopted as a national slogan. It takes space power to keep space for peaceful purposes.

With respect to the (implied) statement, "All is well—back to your fallout shelters," there are very few fallout shelters.

David W. Johnston  
Washington, D. C.

### Quite Right

To the Editor:

Your article on Saturn S-IB (M/R, Nov. 13, p. 17) refers to "Launch Complex-39 which will have two pads and will be completed in 1963."

I am sure you must mean Launch Complex-37, now under contract to be completed in 1963.

George Schlesinger  
Ets-Hokin & Galvan, Inc.  
San Diego, Calif.

### Counterdust

To the Editor:

The "meteoroid hazard" (M/R, Nov. 6, p. 32) can be effectively met by maintaining loose material varying from over an inch in size down to a fine dust where it will be drawn over the puncture by the escaping air.

Theodore B. Dufur  
Los Angeles



# The Countdown

## WASHINGTON

### FCC-White House Joust over ComSat

A hot fight is under way between the FCC and other Administration officials over ownership of the planned commercial communications satellite system. If not resolved quickly, the battle is certain to spread to Congress. FCC officials, in opposition to White House plans, favor the establishment of a profit-making corporation to operate the commercial communications satellite net. The common carriers would own the stock.

### Bomarc B Base No. 3

The third U.S. *Bomarc B* base is nearly ready to join NORAD. The base is at Niagara Falls, N.Y., Municipal Airport. Two other *Bomarc B* sites—Duluth, Minn., and Kincheloe AFB, Mich.—already are operational. In all, five are planned within the borders of the United States, two in Canada.

### Saturn on the Canal

The ground-support debate in NASA over whether a canal-barge system or a rail transporter should be used in the *Saturn C-4* launching complex appears to have been settled. The winner: The canal-barge. The main reason: It is expected to be cheaper.

### Navigation for A-3

Navy sources say that a new gyro appears to have assured development of the improved navigation system needed for the 2500-mile-range *Polaris A-3*. The gyro—the Mark 1 Mod 2 developed by Sperry—has already undergone trials aboard the nuclear-powered sub *Ethan Allen*. The additional range of the *A-3* considerably increases the need for accurate navigation of *Polaris* submarines.

### Enterprise to Get Advanced Terriers

The huge nuclear-powered *Enterprise* has joined the fleet without any surface-to-air weapons, but she is scheduled to receive *Advanced Terriers*. One battery of the Convair missiles will be installed on her port quarter, one on her starboard. No date for the retrofitting has been set.

### Titan I: In the Green When?

The first nine-missile squadron of *Titan I's* now is not officially expected to be declared operational until sometime in January. However, there is a chance that the first complex of three Martin *Titans* at Lowry AFB, Colo., may be declared operational this month to keep the slipping operational date for the first *Titan* within 1961.

### NASA to Write Nova-S Specs

The Golovin Committee is understood to have recommended that NASA be permitted to continue writing the

specifications for the solid superbooster to be developed by the Air Force. The committee reached no decision on whether the motors of the solid booster should be 160 or 240 inches. A compromise is expected.

## INDUSTRY

### Ling-Temco the Winner—Apparently

Ling-Temco-Vought appears to have won its merger battle with the Justice Department. The government has failed in District Court to stop the uniting of Ling-Temco and Chance Vought, and the chances of a government appeal look slim.

### R&D Intelligence

The \$10-million award of an AEC contract to STL for development of a *Vela Hotel* satellite is seen as a small first step toward a much bigger program . . . Appointment of Dr. James H. Gardner, VP of the National Research Corp., as Pentagon Deputy Director of R&E for engineering and chemistry is expected by some to give a new boost to chemical research. . . .

### Instant Rebates

The Navy is planning to switch its policy on rebates due the Government under price-revision clauses in contracts. Formerly the Navy waited to collect until a final contract price was negotiated. A new directive will call for immediate refunds.

## INTERNATIONAL

### Missile/Space Consortium Established

A European industrial consortium is being established to develop missiles and jet aircraft for NATO. Among the principal firms involved are Hawker-Siddeley of Britain, Breguet of France, Focke-Wulf of Germany, Fokker of the Netherlands and Avions Fairey of Belgium. Republic is reported to be interested in joining.

### Overseas Pipeline

SEREB has been successfully testing 7000-lb. *Agathe* rockets at the Hamaguir Range in the Sahara . . . The site for the BMEWS No. 3 Station at Fylingdales in Yorkshire is being reduced from 2400 to 900 acres . . . COSPAR has decided to hold its Third International Space Science Symposium in Washington next May.

### Russian X-15?

Observers report seeing Russian turboprop Bear bombers carrying a swept-wing rocket plane under their fuselages. Reports say the rocket plane could be an air-breathing missile but appears more likely to be a Soviet version of the *X-15*.

## Way Cleared for ComSat Operation by Profit-makers

The Kennedy Administration is expected to announce in the near future support for a private, profit-making corporation to run a commercial communication satellite system.

The recommendations will call for congressional action to enact them into law. This will take the decision on ownership of the satellite system out of the hands of the Federal Communications Commission, where it now lies.

Preparation of the Administration position was the work of the National Aeronautics and Space Council, which consulted with interested government agencies.

Informed sources report that the council's recommendations were ready for submission to President Kennedy last week.

They called for:

- A profit-making corporation to be set up with private—not public—ownership.

- Ownership of stock in the corporation would not be restricted to communication carriers. It was not clear whether the council's proposal would open ownership to private individuals or simply to foreign communication carriers and equipment manufacturers.

- Some form of government body would be set up to ride herd on the corporation to insure that all U.S. government interests were protected. This could take the form of one individual, the space council or a special committee.

- NASA would proceed with research and development of the system and would provide technology, launch vehicles, tracking network and possibly equipment to the corporation.

The Administration decision to put the final decision on ownership of the system up to Congress means that final action will be put off until next year. The ensuing congressional consideration might delay it until late in the year.

Submission of the ownership decision to Congress will probably also touch off a jurisdictional battle between various congressional committees. Logically, such legislation would

be introduced in the commerce committees of both houses of congress.

Sen. Robert S. Kerr, (D-Okla.), Chairman of the Senate Space Committee, muddled the picture when he announced that he would introduce legislation on the subject. Sen. Russell Long (D-La.), chairman of the Senate Small Business Anti-monopoly Subcommittee, is also reported to be preparing legislation.

All of the Administration and congressional action means that the proposal by U.S. communication carriers for a non-profit corporation to run the system is dead.

## Shots of the Week

A chimpanzee circled the earth twice in a *Mercury* capsule on Nov. 29 and was recovered successfully. Technical problems prompted NASA to bring down the capsule after two, rather than the planned three orbits (see story on p. 14).

In military launchings:

- A Strategic Air Command crew fired an *Atlas* from a semi-hard launch pad at Vandenberg AFB, Calif., Nov. 29 in a combat readiness test. The crew was from the 576th Strategic Missile Squadron.

- A *Titan*, first to be launched by a "blue suit" crew from Air Force's Aerospace Test Wing, was fired Nov. 21 down the Atlantic Missile Range. The ICBM carried a warhead designed by General Electric for the *Nike-Zeus* AICBM tests coming up in the Pacific next year.

- The Air Force launched an *Atlas-Agena B* carrying either a *Samos* or *Midas* satellite from Point Arguello on Nov. 22. Details of the firing were kept secret.

- Test firings of *Asp-Apache* research rockets from Roi-Namur island off Kwajalein in the Pacific began Nov. 15, the Army disclosed. They are part of the *Highball* series used in connection with the *Zeus* test program (M/R, Jan. 30, p. 44).

## MacBride Quits G-D

C. Rhoades MacBride has resigned as executive vice president of General Dynamics Corp. He had headed the five western aircraft/mis-

sile divisions which were created in a company reorganization earlier this year. R. C. Loomis, president of General Dynamics/Convair, which has operated the troubled 990 jet transport program, also is leaving the company.

## Reds Block Cooperation Plan

Soviet insistence that the UN's Committee on Peaceful Uses of Outer Space favors the Western military bloc has thrown a damper on the new U.S. plan for a joint weather and communications space net.

The Russians ended their long boycott of the committee last Monday, but delegate Zorin reaffirmed the Soviet position favoring committee reorganization on the basis of equal representation for Western, Communist, and neutralist nations. He also said that nothing could be accomplished in this area without U.S.-Russian agreement.

## AIA Blasts Exhibitionism

The Aerospace Industries Association moved last week to crack down on costly defense products displays at technical meetings and conventions.

A resolution criticized "the multiplicity of exhibitions, and unnecessary diversion of effort, money, and attention from the more important endeavors in which members are engaged." The statements were directed at both industry and sponsoring societies.

## Kimball to Head AIA Board

Dan A. Kimball, president of Aerojet-General Corp., has been elected chairman of the board of governors of the Aerospace Industries Association for 1962.

William M. Allen, president of The Boeing Co., was named vice chairman, and August C. Esenwein was elected president. Esenwein replaces Orval R. Cook, who retires Dec. 31.

Also elected to the executive committee of the board were: Donald W. Douglas, Jr., president, Douglas Aircraft Co., Inc.; H. M. Horner, chairman, United Aircraft Co.; and Carl G. Holschuh, executive vice president, Sperry Rand Corp.



George F. Hannaum was elected vice president; and Samuel L. Wright, secretary-treasurer.

Other members of the board are company presidents: J. R. Kerr, Avco Corp.; O. A. Beech, Beech Aircraft Corp.; Malcolm P. Ferguson, The Bendix Corp.; William M. Allen, The Boeing Co.; Donald W. Douglas, Douglas Aircraft Co.; Earl D. Johnson, General Dynamics Corp.; E. Clinton Towl, Grumman Aircraft Engineering Corp.; A. G. Handschumacher, Lear Inc.; William S. Bergen, Martin Co., a division of Martin Marietta Corp.; J. S. McDonnell, McDonnell Aircraft Corp.; Thomas V. Jones, The Northrop Corp.; Mundy I. Peale, Republic Aviation Corp.; and J. W. Crosby, Thiokol Chemical Corp.;

Also, G. J. Lynch, vice president and general manager, Aeronutronic Division of Ford Motor Co.; J. C. Garrett, chairman, The Garrett Corp.; Jack S. Parker, executive vice president, General Electric Co.; H. H. Dice, general manager, Allison Division of General Motors Corp.; L. A. Hyland, vice president, Hughes Aircraft Co.; Courtlandt S. Gross, chairman, Lockheed Aircraft Corp.; J. H. Kindelberger, chairman, North American Aviation, Inc.; A. L. Malcarney, executive vice president, Defense Electronic Products, RCA; J. D. Wright, chairman, Thompson Ramo Wooldridge Inc.; H. M. Horner, chairman, United Aircraft Corp.; and Albert Boyd, vice president, Defense Products, Westinghouse Electric Corp.

### Captive Dipoles Spotted?

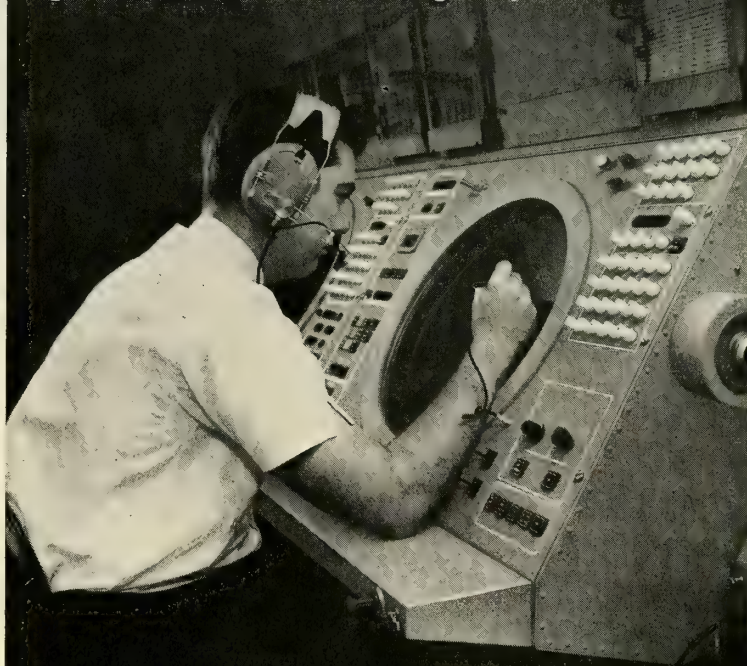
Despite a fourth radar sighting of what is probably the Project *Westford* needle package, Lincoln Laboratory holds out little hope that the copper dipole payload orbited Oct. 21 will ever be released.

Radar returns from an object of about the right size and orbit were announced on Nov. 3, 13, 15 and 22, but signal strength is too weak for positive identification.

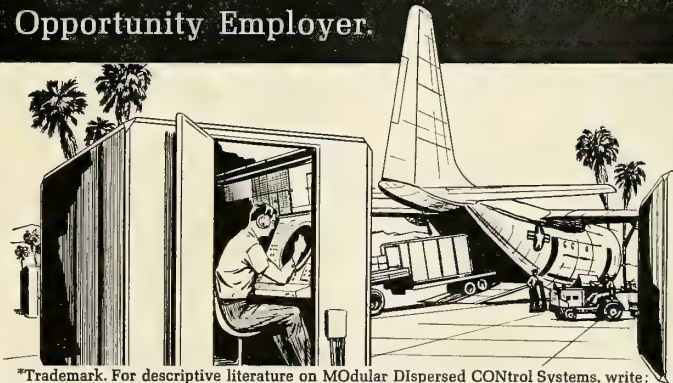
Detection of the 2000-mile-high object has been made by the 2-degree beamwidth Millstone Hill antenna in Westford, Mass. Continuing search with this antenna may refine orbital information to allow detection with the .15-deg. beam Project *Westford* antenna, on the same frequency as the copper needles.

missiles and rockets, December 4, 1961

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# New U.S. Command System Coming

**DOD expected to tap Air Force-Mitre team for  
R&D of sweeping revision in nation's 'war button' network**

THE PENTAGON is nearing a top-level decision on initiating development of a new National Command and Control System to enable the United States to fight any kind of war in the Missile/Space Age.

Such a vast electronic system would be designed so that the United States could command and control all its forces in a deliberate, swift and flexible manner—regardless of the type of attacks the nation might undergo.

In effect, today's vulnerable, all-but one-shot nuclear war button in the White House would be converted into a series of highly survivable buttons that

could be used in a variety of ways over an extended period of time.

A secret report on U.S. needs for development of a closely-integrated, electronic National Command and Control System of this type is now before Defense Secretary Robert S. McNamara. The report is the result of some two months of study by a McNamara-appointed task force headed by Gen. Earle E. Partridge (ret.), former commander of NORAD.

The Partridge Study is reported to call for a new National Command System in conjunction with reorganization of the command structure. The reorgan-

ization is reported to include the creating of a Supreme U.S. Military Commander over nearly all combat forces—an extremely controversial proposal opposed by many congressmen.

McNamara must decide whether to work on development of the National System should begin immediately, who would have overall charge of the program and who would direct the development work.

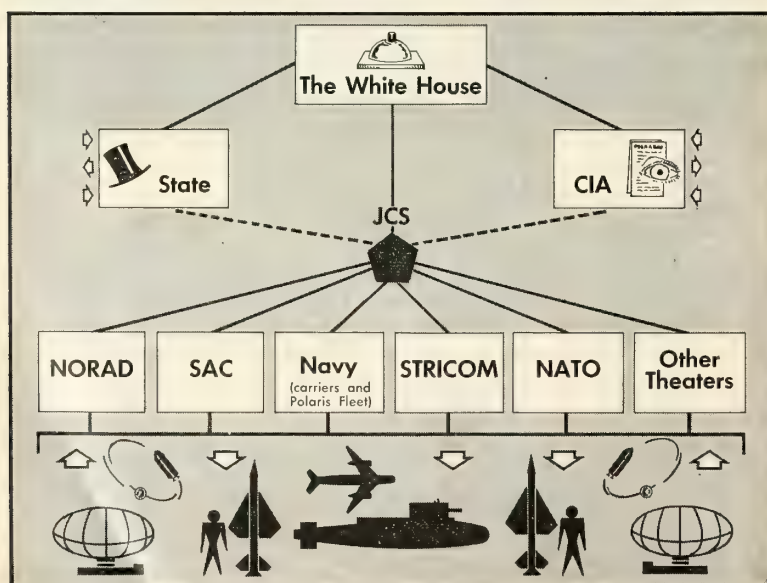
• **Logical choice?**—The Air Force's Electronic Systems Division (ESD) at L. G. Hanscom Field, Mass., and its technical associate, the non-profit Mitre Corp., are considered by many experts in the field as the logical choice for this big development assignment for the Defense Department. This conclusion is based on their broad past and current experience.

However, some parts of the program are expected to be assigned to other groups and agencies where some of the highly-specialized capabilities needed now exist.

ESD, with the strong support of Mitre in varying degrees, is directing the development and construction of 14 Air Force command and control systems of different types—the famed "L" systems. Moreover, ESD and Mitre are planning the integration of all of these and future Air Force command and control systems into one worldwide Aerospace Command and Control System.

These operations already involve a total Air Force outlay of about \$1 billion a year.

The National System would carry the integration process one large step higher to the pinnacle of the U.S. command structure, controlling all missiles and rockets, December 4, 1961



COMMAND AND CONTROL SYSTEM must integrate partly independent systems.





STATION NO. 2 in BMEWS net—Command and Control System 474L—recently went into operation at Clear, Alaska.

mand structure. In doing so, the Aerospace System would be tied in with other generally independent systems such as the *Polaris* Fleets' communications net.

Essentially, ESD and Mitre would have the job of assuring flexible national command and control of all U.S. Armed Forces.

- **By ADSID out of SAGE**—The buildup of ESD and the Mitre Corp. began in 1958 with the establishment of Hanscom of what was then called ADSID—the Air Defense Systems Integration Division.

The Air Force established ADSID to handle the integration and engineering work on the SAGE continental air defense network which had been developed by MIT's nearby Lincoln Laboratory. Mitre was established in September, 1958, to provide ADSID with technical support not available within the Air Force.

The non-profit corporation was built around a nucleus of SAGE scientists and engineers who transferred from Lincoln Laboratory. C. W. Halligan, director of military engineering at Bell Telephone Laboratories, was named president.

In 1960, ADSID was expanded into the Air Force Command and Control Development Division—nicknamed C<sup>2</sup>D<sup>2</sup>—and assigned the development of all Air Force command and control systems. The Electronic Systems Center at Hanscom had responsibility for production of the systems. Finally, last April, the two agencies were joined to form ESD.

- **Growth**—Throughout these various reorganizations, the Air Force has

continued to expand and strengthen their own and Mitre's operations.

Today the corporation's payroll has grown to about 1500 people including a professional staff of about 500. About 10% have doctorates; about 35% of the rest of the professional staff have master's degrees.

Contracts for FY '62 to date are expected to total about \$30 million. Some \$27 million of this is from the Air Force. The rest is from other military agencies and FAA. Contract fees—they average about 5%—are being used for construction of facilities.

The corporation is divided into three major groups: Systems Planning and Research, Systems Engineering, and Control and Sensor Systems Development.

- **Uniqueness**—But numbers and organization tables do not tell the story. The essential contribution of Mitre is based on the fact that the company has put together a unique group comprised of many of the nation's top experts in electronic command and control systems.

Mitre describes its current operations as: "Advanced system analysis and planning, intersystem integration, general system engineering, initial system design, technical advice and research and experimentation."

All of this is not provided for each "L" system. For many of the systems, Mitre provides only small amounts of technical advice on request. The bulk of Mitre's major efforts is concentrated on a few systems.

However, it is in work on these few systems that the trend of the corporation's future operations as planned by

ESD can be clearly seen.

A prime example is 425L—the NORAD Combat Operational Center. Here Mitre is doing the system design works and assisting ESD in making sure that this design is followed.

In the near future, ESD is expected to assign Mitre the same role on at least four other systems: two that are now in existence as projects and two new ones. Some possible new systems currently under analysis are an Advanced Aerospace Offensive System (601L), an Advanced Aerospace Defense System (602L), and a Tactical Forces System (603L).

- **Working closely**—The essential factor needed for fully understanding Mitre's role in the development of these systems is an understanding of the nature of the command systems themselves. As Charles A. Zraket, Mitre technical director of systems planning and research, put it recently:

"Weapons can be designed and built and handed to the user. But the command and control of a missile and its tactical use are problems that you can not separate from the user and his organization. Therefore, it is very important that we work very closely with the user."

Command is a military job. Theoretically, it would be best for the user to do it—to design his own electronic command system—because he has been doing this job for the last 2000 years. But command and control can no longer be exercised by dispatching couriers or looking up troop dispositions in log books when ICBM's flash across oceans in 30 minutes. Digital computers pro-

(Continued on page 40)



**Enos orbits twice...**

# Big Add-on Program for Mercury Planned

NASA IS EXPECTED shortly to follow-up the successful two-orbit flight of a chimp with plans for a \$400-million add-on to the *Mercury* program involving two new spacecraft.

Meantime, troubles which developed aboard the *MA-5* chimp capsule while in orbit Nov. 29 virtually killed the last slight hope of a manned *Mercury* orbital flight this year. The difficulties also prevented the capsule from making its programed third orbit.

Prior to the shot, NASA officials had tentatively set a date in late December for the manned attempt. But the *MA-5* capsule developed an inverter overheating problem, along with a hydrogen peroxide roll-jet malfunction, which has prompted a new evaluation of the manned *MA-6* timetable.

*Mercury* officials indicated that both of the trouble spots could have been overridden by a man. But they said the data would have to be examined, taking about 10 days, to determine if changes would be needed—cutting deeply into the dwindling remainder of 1961.

The *Mercury* add-on, MISSILES AND ROCKETS has learned, would mean modifying a present *Mercury* capsule so that it could sustain a man for an 18-orbit trip, and building a brand-new capsule which would carry two astronauts on earth-orbital flights lasting more than one week.

Intended to bridge the gap between *Mercury* and the start of *Apollo* three-man flights in 1964, the 18-orbit flights would be attempted in late 1962 or early 1963 and the two-man flights in 1963 and early 1964. The plan, which would have to receive Administration and congressional approval, is understood to have been advanced by McDonnell Aircraft Co., prime for *Mercury*.

• **Clean getaway**—The long-delayed *MA-5* shot, hit by a hydrogen peroxide

leak which prevented a launching Nov. 14, got off cleanly from Cape Canaveral at 10:07 a.m. Nov. 29, three hours later than scheduled. There were holds of 1½ hours because of a telemetry problem in the capsule and for 15 min. while a communications link between the capsule and command center was rechecked.

The chimp—named Enos and one of five specially trained for the flight—rode in a special Environmental Control System (M/R, Nov. 13, p. 16) that permitted him to perform certain tasks that were monitored by TV and telemetry. During the 181-min. flight, about 170 min. of it weightless, doctors reported Enos “didn’t miss a trick” and scored almost 100% on his tasks.

Excessive heating of two inverters was detected midway in the second 146-96-n.-mi. orbit as the capsule sailed over Woomera, Australia. The heating pushed the capsule’s interior temperature to 100°F and the chimp’s closed life support unit to 80°.

• **Saving package**—A decision to cut short the flight was made as it approached Point Arguello, Calif., and the spacecraft’s retros were triggered from there for the descent. NASA officials said later they thought the capsule could have completed three orbits, but they saw no reason to risk losing the experiment.

They said that if a man were aboard he could have controlled the heating problem by switching to a third inverter, allowing the other two to cool down. He also could have shut off the roll jet which was malfunctioning.

The descent was terminated in a near-perfect recovery operation added by calm seas. Impacting in the water at 1:08 p.m. EST, 220 mi. south of Bermuda, the capsule was picked up by a helicopter at 2:53 p.m. and brought to an aircraft carrier. Doctors aboard the carrier said Enos appeared to be in excellent health (he underwent 7½ g’s at liftoff) and had functioned normally throughout the flight.

Enos was the first chimp orbited by the U.S. in a dress rehearsal for a manned *Mercury* flight. Whether a second chimp shot will be conducted was uncertain last week. There was a possibility one might be ordered before or after a manned flight.

• **Glenn choice confirmed**—On recovery of the chimp NASA announced that Astronaut John H. Glenn (M/R, Nov. 20, p. 9) would be the first U.S. citizen to try to duplicate the feat of Russian Maj. Yuri Gagarin last April 12. Malcolm S. Carpenter will be Glenn’s backup. Astronaut Donald K. Slayton was tapped for the second manned *Mercury* orbital flight, with Walter M. Schirra as backup. ■

## Rendezvous Check

### Golovin Group Ordered To Re-examine Concepts

TOP KENNEDY Administration officials have ordered the Golovin committee to take a new, hard look at one of its major recommendations—orbital rendezvous.

The new meetings—with primary emphasis on the propulsion and guidance to be used—will continue from two to four weeks.

Usually reliable sources report that the meetings were called by the White House because of new intelligence information.

This was denied by NASA and Defense Department public information officers. The meetings were termed “simply routine.”

Other top NASA, DOD, and White House officials disclosed that the meetings were not routine, but were of a serious, special nature.

As one official put it, “It is clear that orbital rendezvous is needed not only for the manned lunar landing program but also for further manned interplanetary exploration, and for such military uses as intercepting, inspecting and even destroying hostile satellites or space stations.”

In effect, he said, the Golovin committee has been told to take another look at its recommendations to insure that they will not only fill the requirements for Project *Apollo*, but also the needs of further programs and the DOD.

In particular, the areas of guidance and propulsion for orbital rendezvous are to be further explored to insure that the state of the art is sufficient to solve the difficult problems involved in mating two spacecraft while in orbit.

• **NASA-DOD split?**—The same sources also report that there is friction between NASA and DOD members of the committee which was set up to study the long-term needs of the space program—with emphasis on required launch vehicles. This could stem from the desire of the Air Force for a greater role in developing the orbital rendezvous concept and a DOD belief that NASA plans for rendezvous will not fill the total needs of the space program.

The Golovin committee’s major recommendation—when it originally wound up its work about three weeks ago—was that orbital rendezvous be pushed as the best method of achieving a manned lunar landing. The *Saturn C-4* with four F-1 engines was proposed as the launch vehicle for the *Apollo* spacecraft. ■



# NASA, NAA Making Apollo Plans

**Early work on craft design pays off for firm with valuable experience on X-15; team must still be assembled**

NORTH AMERICAN Aviation begins talks with NASA this week on the management program and subcontracting structure for the three-man *Apollo* spacecraft which is to land a team of American astronauts on the moon by 1967.

Selection of North American as the winner in one of the most important competitions ever held in the missile/space industry was announced by the space agency on Nov. 28. NASA said the contract to be negotiated with NAA will be worth \$400 million in its initial phase.

The spacecraft will be built at NAA's Space and Information Systems Division in Downey, Calif. North American is to develop two sections of the capsule. It also will be in charge of integrating the work of other contractors on the program still to be named by NASA.

The NASA announcement specified that North American will develop the command and service modules of the spacecraft. The lunar landing and orbiting laboratory modules are to be developed under separate associate contracts to be awarded within six months.

• **Payoff**—North American already is at work on engineering of the *Apollo* craft. A team of some 90-100 engineers continued work following submission of NAA's bid in the competition.

"We haven't stopped," division President Harrison A. Storms Jr. told MISSILES AND ROCKETS. "It was a gamble to save time that paid off."

The decision to keep the team at work was made in an effort to achieve a better understanding of the total design problems and to nail down concepts in advance of talks with NASA which will firm up the program, Storms said.

Four major subcontractors worked with North American on the proposal that was submitted to NASA: AiResearch Division of the Garrett Corp. on life support; Minneapolis-Honeywell on secondary guidance and control; Collins Radio on communications; Radioplane division of

Northrop on the parachute recovery system.

NASA said prior to the award that it would not necessarily accept the teams that bid in the competition. Final makeup of the subcontracting team is one of the items to be discussed in the talks between NAA and NASA.

"We think they will go with this group, but that is one of the things to be decided," Storms said.

Unsuccessful bidders in the competition were General Electric with Grumman Aircraft, Space Technology Laboratories, and Douglas Aircraft; McDonnell Aircraft with Lockheed Aircraft, Ling-Temco-Vought and Hughes Aircraft; General Dynamics with Avco; and Martin-Marietta Co.

• **General surprise**—Announcement of the award came at least a week earlier than anticipated by most of the competitors, catching North American as well as the unsuccessful entrants by surprise. Late-afternoon announcement of the winner came hard on the heels of a strong rumor earlier in the day that General Electric had won the competition.

NASA had no explanation for the early announcement other than to point out that it had said the award would be made as soon as possible. The agency said nearly 200 engineers and scientists in both NASA and the Department of Defense had evaluated the proposals of the five contractors or teams bidding on the *Apollo* prime contract. Unsuccessful bidders will remain in contention for other *Apollo* contracts, including positions on the North American team.

June 30 of next year is the deadline for assembling of the industrial team which will build the spacecraft.

SISD President Storms said a team of about 1000 will be assigned to the project at the Downey division. It will be set up as a separate and integral organization assigned to *Apollo* for the full life of the program.

(Continued on page 38)

## New Name and Mission Changed Division's Fortunes . . .



STORMS

NORTH American's Space and Information Systems Division changed its name and its fortune just about one year ago.

Since that time, the space-oriented business of the newly named prime contractor of the *Apollo* spacecraft has mushroomed—including awards of \$599 million in new contracts in the last 90 days.

Much of the credit belongs to Harrison A. Storms, Jr., division president.

The division originated in 1946 as a handful of scientists known as the "Aerophysics Lab" located in a tiny corner of NAA's Los Angeles division. The future of the group was very dim several years ago, when its contract for the *Navaho* missile was cancelled.

Struggling along on contractual odds and ends, the division eventually won the contracts for the *Hound Dog* missile and NASA's *Little Joe* booster.

The big break came last December when its name and mission were changed. Instead of unmanned projects, the division began to specialize in space systems.

Since that time, the record has been

good. It holds two study contracts with NASA—one for a paraglider for booster recovery and the other for a self-erecting space platform. In addition, it has won the \$140-million contract for the *S-II* stage of the *Saturn* booster and the *Apollo* award of over \$400 million.

Its employment roster has reached 7800, with 1300 hired since the name change.

One interesting proof of the division's progress is that the \$599 million in contracts in the past 90 days contrasts with total divisional sales of only \$108.1 million in all of Fiscal Year 1961.

✱

# Late '63 Launch Still Goal for OAO

**NASA's heaviest unmanned satellite to provide  
best look at stars; Grumman's \$3-million investment**

by Michael Getler

NASA IS STILL hoping for a late 1963 launching of the telescopic Orbiting Astronomical Observatory (OAO)—intended to provide U.S. astronomers with their first unimpaired glimpse of the universe.

Here's how the \$30-million program stands today—one year after its initiation:

—Fabrication of an engineering prototype is under way at Grumman Aircraft Engineering Corp.'s Bethpage, L.I., plant. Grumman, the prime contractor, expects to complete this phase late next year or early 1963.

—First flyable version is expected to be delivered in August, 1963, and a second unit two months later.

OAO, a 3300-lb. satellite crammed with 1000 lbs. of instruments, is to be lofted into a circular 500-mi. orbit with an *Atlas Agena B*. It will be NASA's heaviest unmanned satellite.

The two major experiments to be carried by the first OAO will involve stellar observation in the ultraviolet region. One is being prepared by the Smithsonian Astrophysical Laboratory and the other by the University of Wisconsin.

The SAL experiment will map the entire celestial sphere in uv to 1100 angstroms (the region below 3000 angstroms is obscured to terrestrial observatories due to the earth's atmosphere). Brightness intensities of at least 200,000 hot-stars (temp. ranges between 10,000-50,000°K) will also be recorded with the SAL package. The experiment will utilize a cluster of four eight-in. telescopes, each coupled to a video tube, to map the uv radiation patterns.

Determination of stellar energies in the 3000-8000 angstrom region will be undertaken by the University of Wisconsin equipment. This is the area which can be measured, in part, by present observatories on earth, but considerable question exists concerning accuracy of the measurements.

The two observation experiments will require both ends of the spacecraft shell to be open. It will also require sun shades at both openings. Under normal circumstances, only one sun shade would be needed with the OAO aft-end closed and fully insulated.

Experiments slated for the second OAO are being supplied by NASA's Goddard Space Flight Center. A 36-in.

cassegrain telescope with a wide-aperture spectrophotometer will collect data on specific stars, galaxies, and nebulae. Studies of the sun and planets, and investigation of the absorptive characteristics of the interstellar medium will follow.

• **Steadier than earth**—Margin of error in the OAO telescopes during stellar tracking will be .1 sec. of arc—a feat roughly equivalent to locking onto a basketball at 500 mi. Hence, enormous advances in satellite stabilization and control are demanded.

Indeed, Grumman hopes to make the satellite's platform even more stable than astronomical observatories on earth, where data collection can be hampered by even slight terrestrial vibration. To achieve this and other design objectives, the company has put up \$3 million in new facilities to assemble and test the vehicle. They include:

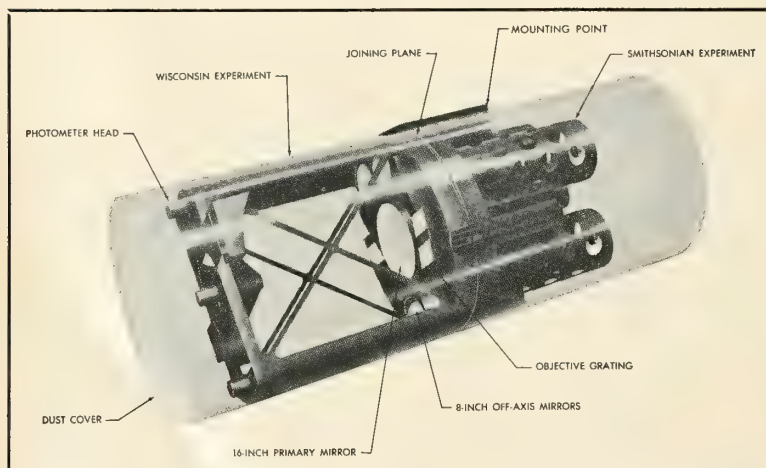
—A 17 by 26 ft. high-vacuum environmental space chamber, capable of housing a complete OAO and simulating thermal conditions 200 miles in space. Atmosphere within this chamber, which allows full temperature and humidity control, can be decompressed to  $10^{-7}$  mm of mercury.

—A 30,000 lb. vibration "shaker," able to impart a 3300 lb. force between 1 and 200 cps to the completed satellite.

—A dust-free, temperature-and humidity-controlled clean room, large enough to accommodate complete assembly of prototype versions of the OAO and all components and sub-systems. Complete equipment for checkout of satellite systems and alignment of all sensing networks is also installed.

• **New facilities**—Grumman began construction last week on a new stabilization and control dynamic test facility, destined to house what company officials feel may be the world's largest three-axis air-bearing spacial simulator.

This device, used for development and testing of the OAO's unique and extremely precise stabilization and control system, is expected to allow a torque sensitivity level below 1000 dyne-centimeters. The 104-in. table of the new



EXPERIMENTAL PACKAGE for first OAO includes stellar observation equipment contributed by U. of Wisconsin (left) and Smithsonian Astrophysical Laboratory.



simulator will rest on a 22-in. steel ball-bearing ground to within 50 millionths of an inch sphericity. The table will support up to 7000 lbs. of OAO developmental hardware and test equipment.

A smaller air-bearing table is already in use. But the 72-in. platform on a 10-in. ball holds only about 700 lbs. of equipment.

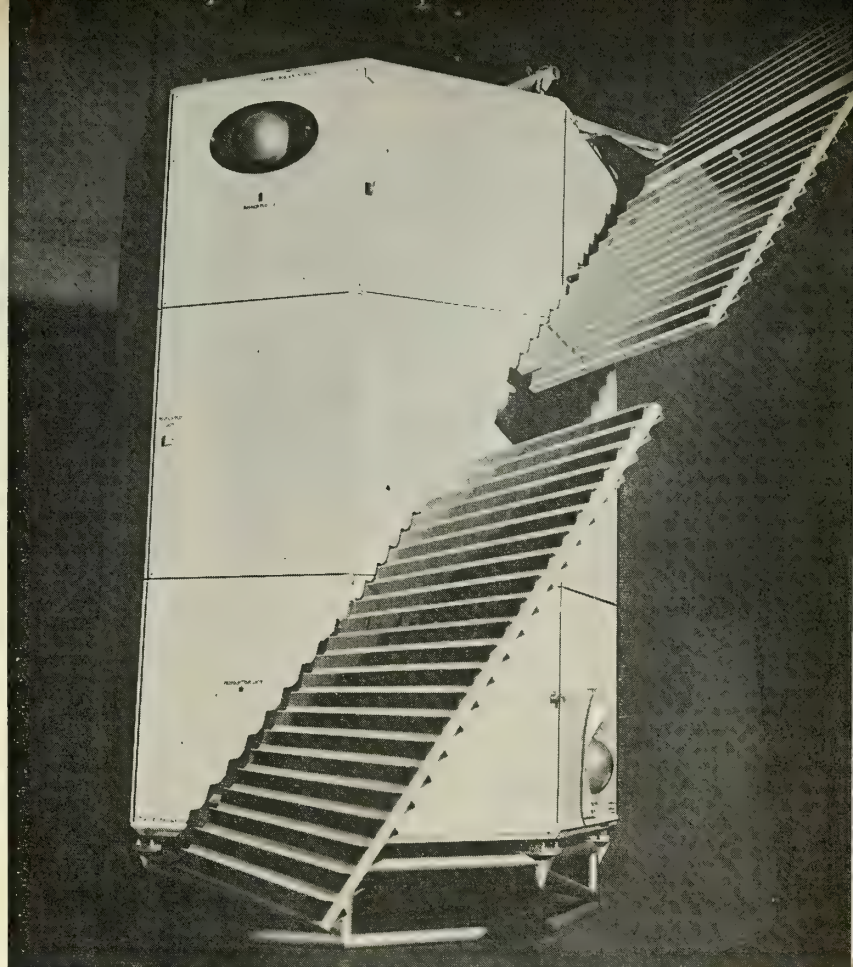
Surrounding the new simulator will be three Helmholtz coils to simulate the earth's magnetic field, providing complete simulation of the spacecraft's moments of inertia.

Also included in the new area will be a solar simulator capable of emissions 40% as intense as those of the sun, and six stellar simulators. Baffles are included in the test bay design to minimize air currents and reduce reflection of stray light from the solar simulator to which the air-bearing platform would react.

The new dynamic test facility—to be ready next spring—will cost an estimated \$150,000. It will be constructed on a spring-mounted concrete seismic foundation to provide the necessary vibration isolation.

Earlier this year, Grumman opened a new 65,000 sq. ft. electronic system center. Now fully staffed and operational, the electronics center is involved with several OAO projects, including testing of the satellite's turnstile transmitting antennas in what is believed by Grumman to be the largest r-f anechoic chamber in existence. The room measures 110 ft. long by 40 ft. wide by 25 ft. high.

• **Tough tests**—Over-all testing of the OAO prototype unit and all sub-assemblies will be based upon levels 1.5 times as severe as those anticipated during actual launch and orbital conditions. Testing of flight models, both by Grumman and NASA, will be accomplished



**FULL-SCALE MOCK-UP** of NASA/Grumman OAO is set up at company's Bethpage location. Small domes (top and lower right) house satellite's star trackers.

at levels comparable to those actually anticipated during flight. A reliability goal has been established for the OAO at 70% probability of operating in orbit for one year.

Here's the flight sequence once OAO is orbited:

After separation from the *Agona-B* booster, a series of rate gyros sense the satellite's tumbling momentum and set-up an error signal. This signal activates a gas jet system which halts the initial motion.

Solar sensors then seek out the sun and align the optical end of the OAO away from the sun and towards the earth.

Now stabilized in pitch and yaw with respect to an earth-sun line to within  $\pm .25^\circ$ , the gas jets are activated in conjunction with momentum wheels and roll the observatory around the optical axis at approximately 2 deg/sec.

As the satellite rolls, the six precision star trackers, one on each of four sides and one on each end, seek pre-determined stellar targets. Initial reference can be established through lock-on by two or more star trackers.

It is possible to pre-select a set of six tracker pointing angles so that there is only one roll orientation at which all six reference stars will be encountered.

Once roll orientation is established, the OAO can be slewed towards any arbitrary position in space by the star trackers and a momentum-transfer system utilizing three sets of inertia wheels. Each set contains a large wheel for coarse slewing to within an accuracy of one minute of arc and a smaller wheel for the fine, or ultimate, guiding capability of .1 sec of arc. The drift rate during fine control pointing is .1 sec arc/per sec.

A television installation is also incorporated in the OAO design to serve as a back-up for orientation purposes.

The problem of excessive vehicle angular momentum resulting from disturbance torques which act continuously on the OAO has been treated in a unique fashion by Grumman.

• **Magnetic unloading**—During star-acquisition and attitude-hold phases of operation, the fine momentum wheels are sufficiently accelerated to cause an-

(Continued on page 39)

## Second Contract Due

**Award of a contract for fabrication of the Smithsonian portion of the OAO experiment is expected this week.**

**The Cook Technological Center in Morton Grove, Ill., has already been selected to do the bulk of the design and fabrication for the U. of Wisconsin package. Armour Research in Chicago is doing the optical design, and the university is fabricating the stellar detectors.**

**Both experiments should be available for assembly with the first prototype OAO.**





JEEP-MOUNTED Entacs ready to fire. Antitank missile may also be launched from armored vehicles and helicopters.



ONE-OPERATOR field mode for Entac battery. Big wallop packed by lightweight missile is spurring production.

**U.S., Belgium among buyers . . .**

## Demand for Entac Boosts Production

**by Jean-Marie Riche**

PARIS—France's potent *Entac* anti-tank missile—now being phased into French Army infantry units—is headed for greatly stepped-up production.

Although some 10,000 *Entacs* already have been turned out by Atelier

de Construction de Puteaux for DEFA (the French Army R&D agency), starting early next year Nord Aviation will become a second source.

The United States, moreover, has signed a licensing agreement with the French government under which it can order the manufacture of more of the missiles. (Sources in Washington said this week that as yet no U.S. contractor for *Entac* had been sought.)

• **Market swells**—Increased output of *Entac* is being brought about both through a French Army decision to replace all Nord SS-10's now in infantry units and an apparent large demand for the weapon by the U.S. and several European nations. The French say that *Entac* has undergone two test series in the U.S. and a number of countries, including the U.S. and Belgium have placed orders in both operational and test quantities.

With this disclosure the French also reported new details of the *Entac*. Weighing just 26.4 lbs. in flight, the 32-in.-long, 17-in.-diameter bird can carry two types of warheads—an all-purpose round designed for use against both personnel and armor, and an anti-tank round described as “the most powerful charge in service for missiles of this type.”

Effective range of the wire-guided missile is 1300 to 6600 ft. The 28.6-lb. command equipment can be handled

by one operator employing a lever which the French call a “broomstick handle.”

One of *Entac's* features is reported to be a long field life—attributable to a new “primer battery” which does not have to be replaced even after lengthy duty in the missile. \*\*



FIRST PHOTO of *Entac* armed with tank-piercing #130 warhead.



ENTAC COMMAND unit weighs 28.6 lbs., contains missile selector and C&C.

missiles and rockets, December 4, 1961



# Technical Countdown

## ELECTRONICS

### Move to Scotland Accelerates

More and more U.S. and British electronics manufacturers are expected to open new facilities in Scotland during the next few years. A broad, skilled labor market, available at appealing wage rates; an eager Board of Trade; the introduction of a new, economical, fast air-freight service; and the lure of the European Common Market could double Scotland's electronics industry, observers say.

### AEC Arms Itself for Tests

Starting next week, the Atomic Energy Commission will fire miniaturized telemetry and other instrumentation from two 155mm guns to test new components under high-g loads. The six-month test program will be conducted at the AEC's Tonopah Test Range in Nevada. Accelerations over 1200-g will be experienced by test items within the projectiles, and data will be telemetered to a series of ground stations. The two 15-ton artillery pieces have been furnished for the tests by the Benecia Arsenal, Calif.

### Now It's Instant Antennas

First of the new "billboard"-type stationary paraboloidal-reflector antennas designed by Boeing Company will be installed for a communications link on the Ryukyu Islands. Ordered by Page Communications Engineers, Inc., for a troposcatter system, the 30-ft. dish can be erected by eight men in about 25 hours. Installation savings, says Page, will amount to \$5000 per 60-ft. antenna. Erection time is cut in half through use of precision-formed and drilled steel girder construction, preformed surface parts, and sequence packaging. Antenna widths available are 30, 60 and 120 ft.

### Mariner Command System Selected

A highly sophisticated flight command subsystem will be developed by Motorola for the *Mariner "R"*, Venus flyby spacecraft, says Jet Propulsion Laboratory. The spaceborne system will receive binary data in phase-shift-key form. Using pseudo-noise techniques, synchronization will be obtained through an advanced coding scheme. In operation, the system processes all on-off commands for other subsystems and programs the control computer. First of the seven launches for the 450-lb. satellite is scheduled for mid-1962.

### Fast Slough Antenna Planned

The British plan to complete their new 85-ft. radio telescope at Slough, a suburb of London, by 1963. The fully steerable antenna will complement the 250-ft. dish at Jodrell Bank. Featuring very fast tracking speed, the \$700,000 Radio Research Station antenna is designed specifically for earth-satellite tracking.

### Prototype ECCM System Delivered

A new mobile transistorized electronic countermeasures system has been built by Sylvania Electric for the Army. For use with field radar units, the system employs a digital computer for advanced target-locating techniques to counteract aircraft jammers. In development since 1955 under a \$3-million program, the prototype system is van-carried and occupies 250 cubic ft. Operational systems could be reduced in size to about 150 cu. ft., Sylvania says.

missiles and rockets, December 4, 1961

## ADVANCED MATERIALS

### Explosive Forming in the USSR

Metal-forming plants in the Soviet Union are being urged to adopt explosive forming methods. Experiments in the forming of automobile floors are being performed at the Balashikha plant. The process here is carried out under water with an explosive charge. It handles several deep-drawing, forming, blanking and flanging operations simultaneously.

### Spectra of Space Radicals to Be Determined

Paramagnetic resonance techniques are being used by the Bureau of Standards to determine frequencies capable of detecting the radicals believed to exist in outer space. Measurements have been completed on the OH radical and the equipment is being modified to handle the spectra of the shorter-lived CH and SH radicals. Once the frequencies are accurately known, the bandwidth of the receiver can be minimized for radiotelescope searches.

### Oxygen Removed from Gyro-Bearing Fluids

An intensive research program by AC Spark Plug Co. scientists has enabled them to eliminate even infinitesimal amounts of oxygen from the liquid bearings of precision gyros, the company announced recently. Since the effects of oxidation in gyros are a prime cause of gyro failure, the company said, the elimination of the oxygen should lead to longer gyro life with consequent savings in money and materials.

## ASTRONAUTICS

### Echo TV System Under Development

A TV camera—mounted on the final stage of the *Echo* satellite launch vehicle—is under development by the Siegler Corp. for Goddard Space Flight Center. The camera will allow designers of the inflatable satellite to study the ejection techniques of the balloon. Information transmitted to earth from the camera will also be permanently recorded on film and magnetic tape.

## SUPPORT EQUIPMENT

### Space Simulator for OSO Delivered

A 10-by-15-ft. space simulation chamber—designated "Envirovac" by its designers, the High Vacuum Equipment Corp.—has been delivered to Ball Brothers Research Corp. for component and satellite environmental testing of NASA's *Orbiting Solar Observatory (OSO)* satellites. The chamber is capable of attaining pressures of  $2 \times 10^{-8}$  Torr—roughly equivalent to 275 miles altitude—without the use of heat or liquid nitrogen in the cryo-panel.

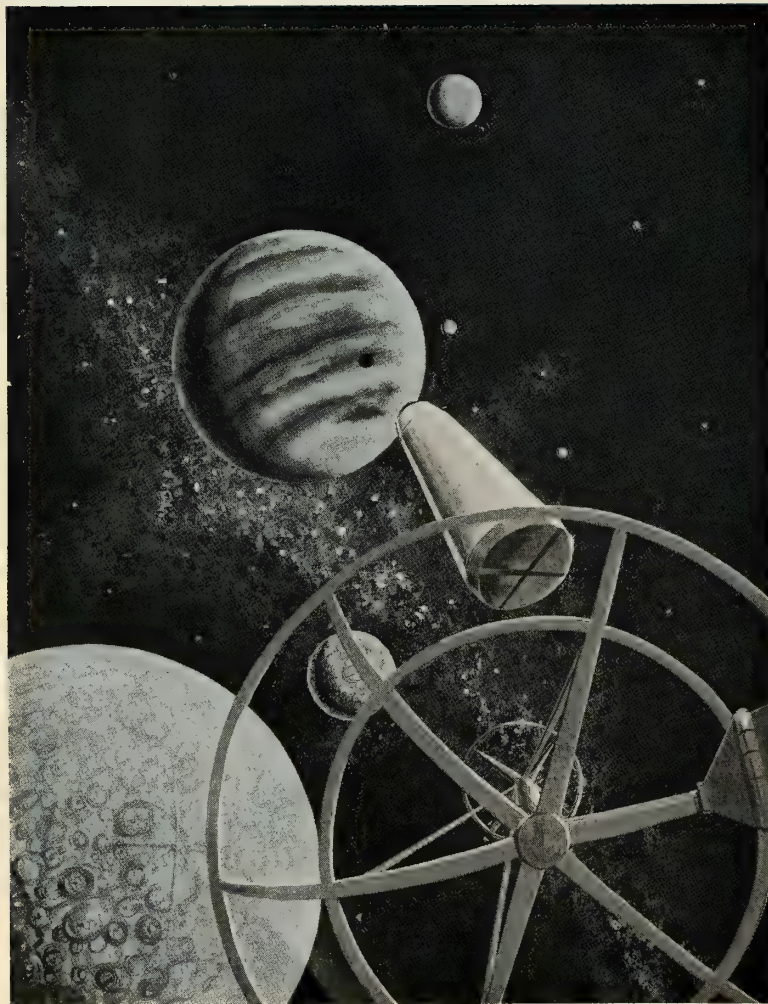
### Hercules Targets to Be Simulated

A target simulator device capable of providing *Nike-Hercules* units with targets resembling almost any enemy bomber is being installed at White Sands Missile Range, according to ARADCOM officials. The system—packaged in a single mobile van—will be used during annual firing tests of *Nike* batteries. Its main advantage, said one Army spokesman, is that unlike the drones previously used for the firing exercises it will effectively train radar operators to recognize and track a variety of high-performance aircraft.

# Jupiter—Probe Target After Mars

*Mars fly-by in '64 will supply guidance and booster know-how; gravity toughest problem*

by Robert L. Forward



*ARTIST'S CONCEPT of spacecraft view of our largest planet, Jupiter, through high-gain antenna. Departing probe on right seeks data on Jupiter's atmosphere. Europa, one of Jupiter's 12 planets, is shown at left.*

JUPITER is the logical next target, after Mars, for an unmanned probe.

Although NASA has not yet drawn plans for such a probe, a substantial part of the needed technology—guidance and booster propulsion—will be in hand if the scheduled 1964 Mars fly-by is successful. Moreover, electrical propulsion units, which are needed for “long-distance” flights, are also expected to be available in the mid-60's.

The remaining pressing problem is to get a probe and instruments strong enough to survive in the crushing pressures near Jupiter's surface. Here is an entirely new field for space technologists to explore—and one that will probably be the pacing factor for Jupiter craft.

Jupiter is one of two bodies in the solar system that man will not be able to exist on for any extensive period of time. (The other body is the sun.) Man can overcome heat, cold, vacuum, radiation and poison gases merely by properly constructing his protective shells, but he can't—as yet—shield against gravity. Jupiter has a surface gravity of  $2600 \text{ cm/sec}^2$  ( $2.65 \text{ g's}$ ), which is mollified only slightly by a centrifugal acceleration of  $-225 \text{ cm/sec}^2$ .

But  $2.6 \text{ g's}$  does not rule out a short trip by man to Jupiter. In a recent experiment a man lived in a  $2\text{-g}$  centrifuge for 24 hours, without protective clothing, to study the consequences of long-duration acceleration. He cooked, ate, slept, stood up, made medical self-observations, and generally carried out other living activities. However, he lost interest in these activities while under stress, and passed most of the time listening to the radio and napping—no way to make precise scientific investigations.

If a manned investigation of Jupiter becomes necessary—and if we develop the rocket power necessary to overcome the gravitational attraction—a man will be able to go down into the upper

missiles and rockets, December 4, 1961



regions of Jupiter for a short period of time. He will have to wear a g-suit and be in excellent condition, but he will be able to carry out a limited amount of experimental work under the high gravitational forces.

The vehicle used in the atmosphere could take many forms. The most obvious method is to use a high-performance jet aircraft, except that instead of carrying the fuel and scooping up oxygen as a jet does on the earth, a Jovian jet will carry the oxydizer and scoop up the fuel in the form of hydrogen, methane and ammonia.

It is doubtful that a manned investigation will prove necessary; we will probably have to content ourselves with observations from orbit and measurements with unmanned probes.

• **The Planet**—Through the telescope Jupiter appears as a golden ellipse with many dark bands parallel to the equator. The dark bands mark the Jovian equivalent of our trade winds. The clouds which form the bands consist of small ammonia crystals suspended in the atmosphere. The various colors observed are caused by contamination of the ammonia crystals with traces of metallic compounds such as sodium.

Jupiter's elliptical shape is due to its thick atmosphere and rapid rotation; its period of revolution, however, is not fixed but depends upon the particular part being observed. Although the equatorial region has a rotation period of 9 hours 50 minutes, most of the rest of the planet rotates at 9 hours and 55 minutes. Various other special features have their own rates of rotation.

Calculations based on the polar flattening have shown that there should be a rapid increase in density from the surface to the center. Since Jupiter's specific gravity is only 1.3, this requires that the outer layers of Jupiter be a gas. Observations of a star as Jupiter passed in front of it gave an average molecular weight for the gas of 3.3. This indicates that the atmosphere of Jupiter is mainly hydrogen and helium, with small amounts of methane and ammonia.

There is still a difference of opinion as to the internal structure of Jupiter. Some suggest that it has a rocky core, a layer of compressed ice containing all the oxygen of the planet, and a deep atmosphere of compressed hydrogen gas with a density of 0.35 just above the ice layer. Others insist that Jupiter has a much higher percentage of hydrogen.

If the planet does consist mostly of hydrogen, there will be no true surface under the atmosphere. As one goes deeper into the atmosphere, and the pressure increases, the hydrogen gas will get denser and denser. Near the center it will be so compressed that it will start to behave like one of the alkali metals.

Even if we knew the composition of Jupiter, the only way to determine its actual structure would be to send probes down into the planet. A great deal depends upon the temperature gradients and heat sources inside.

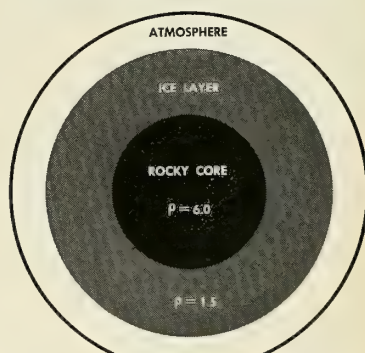
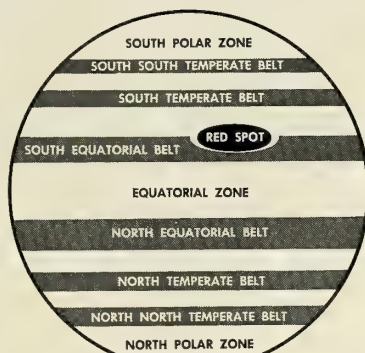
• **The Great Red Spot**—Spots are very common on Jupiter, the most famous being the Great Red Spot. It first became prominent in 1878, slowly turning from a small pink oval to a large brick-red area 30,000 miles long by 7000 miles wide. After this occurrence, older drawings were examined and traces of the spot were found to have existed as long ago as 1664. Since 1890 it has faded considerably—as if it had sunk down into the atmosphere slightly.

The Red Spot does not rotate uniformly with the planet but drifts about considerably; it once wandered away from its mean position by nearly a quarter of Jupiter's circumference. Such freedom of motion shows that the Spot

the larger satellites are given in the accompanying table (page 26) along with those of Jupiter.

Two of the satellites, Io and Europa, are similar to our moon in size, mass and density, and are probably made of rock. Ganymede and Callisto, however, have much lighter densities and must contain a high percentage of lighter materials, probably ice and frozen ammonia over a rocky core.

It is an interesting fact that although the four satellites are all within a short distance of each other and all are comparatively small, traveling between them would involve almost as much power as does a journey between the inner planets. This is because the gravitational influence of Jupiter cannot be ignored in a calculation of the escape velocity. For instance, the escape velocity for Io is roughly 27 km/sec. But only 2.5 km/sec is due to the mass of Io; the remainder is required to escape the gravitational influence of Jupiter.



**LEFT:** The band structure of Jupiter, including the well-known Great Red Spot. **RIGHT:** Wildt's model of Jupiter.

is a floating disturbance. Other semi-permanent markings are observed on Jupiter's surface; all of them wander about, showing that the Jovian atmosphere is deep and complex.

Another feature merely adds to the puzzle. This is the South Tropical Disturbance, a dark area which is in the same zone as the Red Spot but has a shorter rotation period and laps the Spot every few years. It approaches the Spot at several miles an hour, speeding up at it nears, then seems to drag the Spot along with it for several thousand miles. After the interaction, the Great Red Spot drifts back to its mean position while the South Tropical Disturbance continues on its next lap. The variety of motions show that a continuous volcanic action cannot be responsible for either spot.

• **Satellites**—Jupiter has a family of twelve satellites, but only four of them are large enough to be dignified with names: Io, Europa, Ganymede, and Callisto. The known characteristics of

• **Radio emission from Jupiter**—In 1955, intense bursts of radio noise were found to be coming from Jupiter at decameter wavelengths. The radio waves seemed to come from several regions on Jupiter; in particular, from the three large white spots in the South Temperate Belt and the Red Spot when it was near one of the white spots. The amount of energy released in radiation is tremendous. Various speculations have been made concerning their origin: lightning or chemical reactions in the atmosphere, volcanic explosions, or trapped solar particles in a gigantic Jovian Van Allen Belt.

Recent experiments seem to favor the solar particle theory. The radiation is predominantly right-handed elliptically polarized, which points to a magnetic interaction origin. Also, during the last opposition of Jupiter, both the earth and Jupiter were sprayed by high-energy particles from solar flares. There was a definite correlation between the flares from the sun, magnetic storms on





## ***Raytheon solution for space***

Recovery of space vehicles is a long range problem, commencing at atmosphere entry. Techniques for control from re-entry through touchdown, developed by Raytheon, are comparable to GCA concepts. Over the past two years, Raytheon has conducted a major and continuous investigation of the means by which a manned maneuverable space vehicle can be returned safely from flights in space to normal routine landing on earth. These investigations have included operational

control concepts, instrumentation, information flow analysis, basic system requirements and subsystem specifications.

Part of this effort was a space vehicle recovery study for the Air Force Flight Test Center encompassing vehicle energy management, glider characteristics trajectory analysis, flight parameter accuracies, range instrumentation, navigation, communications, data processing display, and human factors.





# vehicle recovery: **LONG RANGE GCA**

Other portions of the effort included earth return navigation and recovery studies for SLOMAR (as a subcontractor to the Martin Company), and joint efforts with Bell Aerosystems Company on DYNASOAR Terminal Navigation Systems.

Currently, major emphasis is being placed on the APOLLO Ground Operational Support System (GOSS). This system will include global range instrumentation for tracking; telemetry and communications;

and control, display and computation centers.

One of the world's largest scientific-industrial organizations, Raytheon has proven capability to create the required technology and manage every phase of a space vehicle recovery system — from early study and design through development, production and field support of operational systems and equipment.

*Executive Offices, Lexington 73, Massachusetts.*

## RAYTHEON COMPANY

EQUIPMENT DIVISION

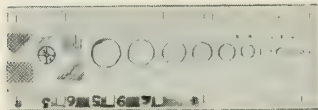
**RAYTHEON**

*Communications, Radar, Sonar, Guidance, Data Processing and Display, Countermeasures, Systems Design and Management, Basic Research*



# NARROW-CHANNEL PHOTOGRAPHY

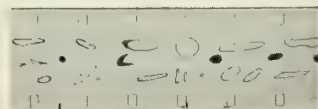
For people with the problem of photographing the interior of long, narrow channels, Kollmorgen has developed unusual devices capable of recording on film channels as narrow as  $\frac{1}{32}$  of an inch.



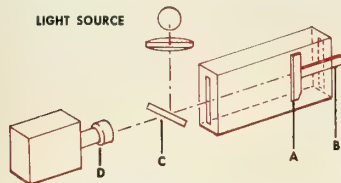
Above, actual size, is a test film of circles and numerals placed within a  $\frac{1}{32}$ -wide channel.



Above is a panoramic view of a continuous section of the same film... with marks enlarged 8x.



Pitting, corrosion, fracture and other defects of interior walls can be continuously recorded with full-dimensional accuracy... of exceptional value in quality control operations.



The secret of our insight: A highly precise 45° mirror (A), mounted on a reed (B), is inserted in one end of the channel. A beam splitter (C) directs a powerful light into the channel from the opposite end which is reflected by the mirror onto the sidewall. The photographic leg of the system receives the image from the channel mirror and through the beam splitter. A camera objective (D) focuses the image on the film. The channel is advanced by a carriage in precise synchronization with the advance of film. Result: a continuous, clear photographic record of the entire channel.

Various modifications of this device have been applied to channels up to six feet long. For longer and wider channels we have designed a miniature self-propelled camera, mirror and light source capable of presenting a continuous image on film with resolution sufficient to reveal scratches and hair-line cracks smaller than .010 inch.

*If you need special insight on "in-accessible" interiors, or information on other unusual applications of optics/electronics/mechanics—let's talk it over.*

Write Dept. 612



the earth and radio emission from Jupiter.

• **Magnetic field**—A detailed study of Jupiter's magnetic field and its variations may explain many of the features on the planet that are puzzling the astronomers.

The magnetic field probably has a magnetohydrodynamic origin similar to that of the earth. If, however, it is due to a metallic hydrogen core, it could be much more complex because of the lower viscosity and higher turbulence.

The extreme high radio noise intensities observed are very likely the interaction of solar particles and the magnetic field. But in order to account for the intensity peaks and variations of the radio noise—and the wavelengths emitted, it is necessary to postulate a very intense magnetic dipole field whose axis and center do not coincide with the axis of rotation and the geometric center. The various spots that are sources of radio noise may be interactions of the Jovian Van Allen Belt with the upper atmosphere—the spots being indications of local variations in the magnetic field which allow the particles to spiral down into the atmosphere instead of being reflected.

The unusual behavior between the South Tropical Disturbance and the Red Spot might also be explained by magnetic interactions.

• **Unmanned probes**—We will definitely want to send probes down into Jupiter's atmosphere to measure the pressure, temperature, magnetic field and composition of the various layers, bands and spots.

The major problem in the instrumentation would be the high pressures involved. The entire probe, including all instrumentation and telemetering equipment, would have to be a continuous piece of matter with no moving parts (the ultimate in solid-state engineering) or else all internal voids must be connected to the external environ-

ment so that the pressure can be equalized on the way down (the leaky sieve concept). Even these methods have limitations, since the pressure might get high enough to cause some metals to flow.

• **When do we go?**—The measurements made of the Jovian system will be important to the research scientists seeking to understand the behavior of the solar system, because Jupiter differs radically from the inner planets, both in composition and structure. But more important, these preliminary measurements will be necessary for the design of the later unmanned spacecraft that will penetrate Jupiter's atmosphere and investigate and land on the satellites.

These unmanned probes, especially the first ones, will probably travel on low-energy orbits. Using the minimum-energy orbit will require 33 months for a one-way trip. If we could get a 1-megawatt power source and a specific power of 0.2 kw/kg then we could put very large probes in an orbit about Jupiter in half that time.

But before man goes to Jupiter (or for that matter, any of the outer planets) it will be necessary to completely re-evaluate the concepts that we have been using in space travel.

Space travel with transit time counted in years, with power and propulsion units operating continuously, will require completely new concepts in equipment reliability.

Before man can go, we will need much larger power sources capable of many megawatts output. Nuclear power is the obvious solution and fortunately the specific power goes up as the absolute power is increased. As we get up to specific powers of 1 kw/kg, we can expect transit time of 1 year or less.

When do we go? Usually long-range scientific estimates in this field prove to be conservative. However, I would estimate that man will be on the way to Callisto and points down in 1985. \*\*

## Jupiter and Larger Satellites

|                                        | Jupiter              | Io                 | Europa             | Ganymede            | Callisto             |
|----------------------------------------|----------------------|--------------------|--------------------|---------------------|----------------------|
| Orbital radius (km)                    | $7.78 \times 10^8$   | $4.22 \times 10^5$ | $6.71 \times 10^5$ | $1.07 \times 10^6$  | $1.88 \times 10^6$   |
| Period (days)                          | 4329                 | 1.77               | 3.55               | 7.15                | 16.7                 |
| Rotation (days)                        | .414                 | 1.77               | 3.55               | 7.15                | 16.7                 |
| Radius (km)                            | 71400                | 1660               | 1440               | 2470                | 2340                 |
| Mass (kg)                              | $1.9 \times 10^{27}$ | $8 \times 10^{22}$ | $5 \times 10^{22}$ | $15 \times 10^{22}$ | $9.0 \times 10^{22}$ |
| Density (gm/cm <sup>3</sup> )          | 1.33                 | 4.4                | 3.9                | 2.4                 | 1.7                  |
| Surface Gravity (cm/sec <sup>2</sup> ) | 2600                 | 190                | 150                | 170                 | 110                  |
| Escape Velocity (km/sec)               | 61                   | 2.5 + 25           | 2.0 + 20           | 3.0 + 14            | 2.0 + 12             |
| Orbital Velocity (km/sec)              | 42.5                 | 1.7                | 1.5                | 2.0                 | 1.5                  |



# DOD Zeroes in on R-F Interference

**AFSC provides management, Armour runs analysis center in unified drive for vital compatibility data**

by Charles D. LaFond

ANNAPOLIS, MD.—The Defense Department is mounting a direct attack on a steadily worsening military-systems breakdowns caused by inadvertent r-f interference.

A single agency—the Air Force Systems Command—is managing the program; there is a single Electromagnetic Compatibility Analysis Center operated by the Armour Research Foundation. The three military services are contributing data in an effort to come up with some answers quickly.

The revitalized Electromagnetic Compatibility Program got underway last summer. The new Analysis Center is now almost fully staffed and by the end of next year its computer facility will be in operation. First output from the Center is expected this month.

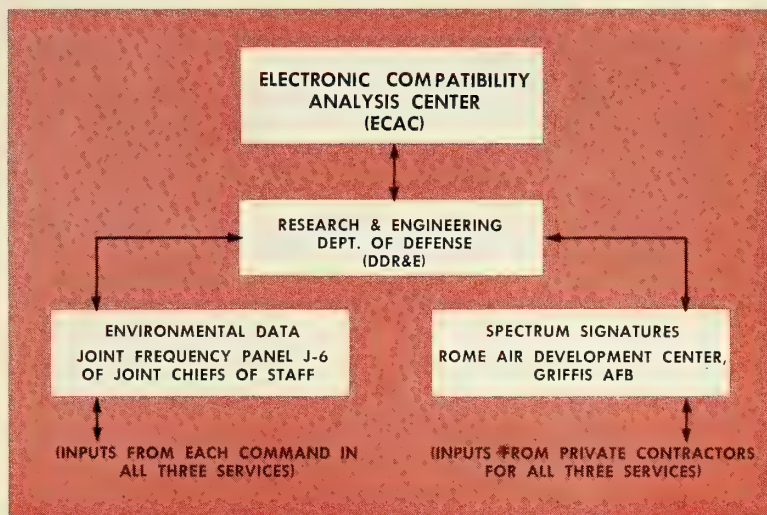
An annoyance in the past, r-f interference today is serious business. Without a better understanding of the problem, satisfactory frequency allocation will be impossible. Improvements in design can only be attained when clearcut technical direction is available.

Already, missile failures, communications jamming, radar blanking and other catastrophic failures have been recorded and later traced directly to intentional r-f interference.

As the number, power, and sensitivity of electronic systems increase, so does the compatibility problem.

While early emphasis in the program will be toward alleviating existing RFI problems, the program eventually will turn toward improvements in equipment design and development.

How important is this? Dr. J. H. Gelman, noted RFI prediction pioneer and former Director of Communications at the AF Rome Air Development Center, recently stated: "RFI might well cost us much more than the opportunity of being first with a man on the moon. It could cause us to lag perennially behind the other world powers in the rocket and missile field



*INFORMATION FLOW for the Electromagnetic Compatibility Program. Policy guidance is provided by DDR&E, coordinated with the Joint Chiefs of Staff. The Air Force Systems Command, Andrews AFB, Md., is responsible for establishment and direction of ECAC; Armour Research Foundation is the prime contractor.*

for years to come."

Speaking before a New York meeting of the Institute of Radio Engineers, the Capehart Corporation scientist stressed the great need for solving RFI problems in missile/space hardware before designs leave the drawing boards.

• **Rebirth of a program**—The present Electromagnetic Compatibility Program was initiated at the request of Acting Defense Secretary James H. Douglas in July, 1960.

By late September, 1961, a basic program was conceived which was designed to prevent the creation of another many-headed and ineffectual monster. Deputy Defense Secretary Roswell L. Gilpatric issued a promulgating memorandum requesting that the Chairman of the Joint Chiefs of Staff and the Director of Defense Research and Engineering each designate a representative to establish and carry out jointly the

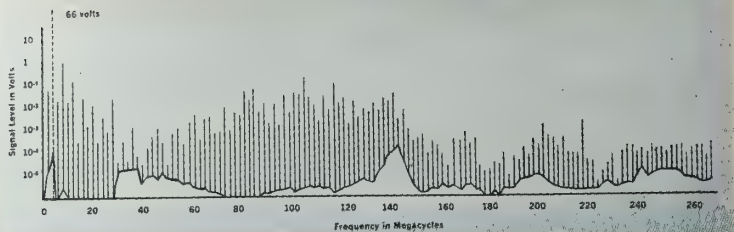
Compatibility Program as requested by Secretary Douglas.

Further, it was stated that the tri-service program would be subject to the authority, direction, and control of the Secretary of Defense.

To bypass troubles encountered in earlier programs also aimed at the solution of radio-frequency interference problems, a single analysis center was deemed necessary to process effectively all data collected by each of the three military services.

Finally, Gilpatric's memo made the Air Force responsible for establishment of such a center and for directing its activities in accordance with policy directives of the JCS and DDR&E representatives.

Those close to the problem over the past 10 years are in accord with the belief that the DOD decision to truly unify the three-service effort in



**UNDESIRED RADIATION** from a typical radio transmitter is plotted by signal intensity on this Armour graph. Assigned transmitter frequency was 4 mc (dotted line), but note the wide range of spurious emissions recorded.

RFI control is not only a most significant move but possibly the only approach to an effective program.

• **New analysis center**—The central data collection and processing facility is located here at the U.S. Naval Engineering Station.

Armour Research Foundation was awarded an 18-month, \$2 million contract last summer for technical operation of the Center. The contract was placed by the Electronic Systems Div., Hanscom Field, for AF Systems Command, although program control is now at AFSC, Andrews AFB, Md.

Presently staffed by 120 persons, largely scientific and technical, the group will be enlarged over the next few months to 167. Technical director over the ARF team is Stanley I. Cohn; director of the Center is Col. Charles C. Woolwine, USAF.

Under an ARF subcontract, the Engineering Experimental Station, Georgia Institute of Technology, is assisting Armour in establishing the Center.

Still to be acquired for the station is its computer facility. Cohn's group now is using the Remington-Rand Univac complex at Armour's Chicago home. Several major computers are now under study and a selection will be made shortly by Armour and the Air Force.

The new data processing equipment, furnished by the Air Force, is scheduled to be in operation by late 1962, Cohn said.

• **RFI studies**  
—Principal mission

of the Analysis Center is to provide an analytical capability for determining radio frequency interference effects on electronic systems degradation. The team also will make recommendations to correct deficiencies in military systems to assure that their future performance will meet design requirements for environments of unintentional RFI.

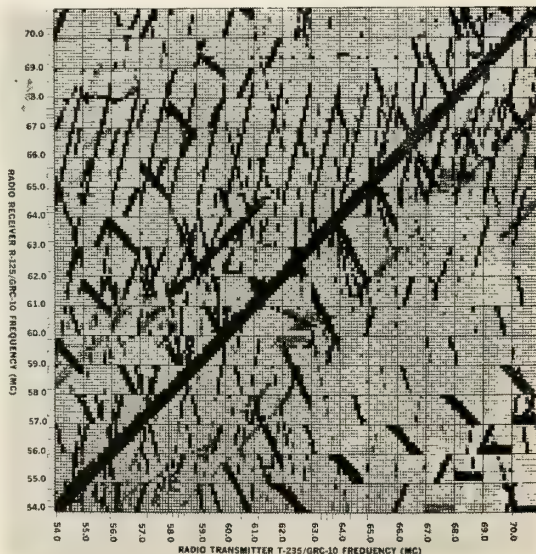
To carry out its mission, the Center will establish a "data base" to satisfy three broad objectives:

—The prediction of interference potentialities among electronics equipments under operational-environment conditions.

—The provision of a central means for improving radio-frequency management within the three military services.

—The establishment of a tri-service consulting organization for R&D programs involving electromagnetic-compatibility.

• **Radar first**—Initial emphasis, ac-



**TYPICAL MUTUAL INTERFERENCE:** Blackened areas on Armour Research Foundation chart indicate frequencies at which interference will occur at the receiver for any given transmitter frequency. (Select a transmitter frequency, move across the chart, and note which frequencies correspond to the darkened areas.)

cording to Cohn, will be placed problems associated with military radar systems. Later, communications problems will be attacked.

Input data to the Center will vary considerably. Basically it will consist of environmental and spectrum-signature information. Environmental data will involve both military situations and deployment of electronic equipment. Individual equipments will be studied outside contractors to each of the services to determine electronic operating characteristics.

The center will then employ the data inputs to determine environmental interaction, frequency allocation information, operational procedures (better compatibility) and possible interference- and susceptibility-reduction measures for offending equipment.

Cohn believes that in time this program should permit better utilization of the r-f spectrum with respect to better frequency allocation and equipment characteristics.

• **New ADP techniques**—Processing of data for electromagnetic compatibility will require new techniques, Cohn asserts.

The center will establish a vast library of data from the field and it will prepare and store the information in form suitable for digital computation.

A continuous effort will be maintained to develop and refine computer programs for analysis. Also, operational research methods will be developed and used for determining the best possible frequency allocations and operational procedures for enhancing compatibility.

• **Parallel studies**—The extremely complex results of analysis, Cohn pointed out, demand better handling methods. Thus, the program will require R&D in the application of data read-out systems, map printing, and environmental display techniques.

The validity of input data also must be considered, he stressed. With experience, the types and accuracy of data requirements will change. Measurement techniques in the field will have to be reviewed and revised as necessary to meet more demanding requirements.

Finally, the Center will have to keep abreast of the rapidly changing electronics art—in interference reduction and in advanced equipment designs.

The task ahead is going to be a tough one, but it will pay for itself many times over if successful. Avoidance of disaster due to ill-timed interference would be a spectacular reward for the effort. Economically, however, the payoff will be even more significant for it should permit the development of future systems for electromagnetic compatibility and avoid the need for correction after the fact.

missiles and rockets, December 4, 1962



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Among our important Government contracts are such significant and interesting programs as Project SURVEYOR, the development of spacecraft to soft land on the moon; and ARPAT, an experimental program for an advanced ballistic missile defense system. In addition the company is sponsoring a strong, forward looking program in space technology research and design of new systems.

If you are interested in building an exciting and rewarding career working on growing projects and tomorrow's technology, please write to me. You will receive a reply within one week.

A handwritten signature in blue ink, which appears to read 'F. P. Adler'.

F. P. ADLER, *Manager*  
Space Systems Division  
Hughes Aircraft Company

# AEROSPACE & WEAPONS SYSTEMS ENGINEERS

*Consider these representative openings:*

These are only a few of the hundreds of openings for both junior and senior graduate Physicists, Electronic Engineers, Thermodynamicists, Mathematicians, Mechanical Engineers and Aeronautical Engineers. To qualify, you should have training or experience which can be applied to space systems analysis, vehicle design, controls, propulsion, missile defense or related areas. We invite your inquiry.

## *Control System Analysts*

Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

## *Orbital Mechanics Analysts*

Trajectory analysis and solution of problems involving conic and perturbation techniques.

## *Senior Dynamicists*

Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

## *Space Power Engineers*

Openings include development of electronic propulsion systems for space probes. Positions call for capability of working in either a project or research capacity on direct energy conversion and storage systems. Openings exist for both junior and senior engineers. An advanced degree in Electronics or Physics is preferred.

## *Aerothermodynamicists*

Experience in hypersonic gas dynamics, heat transfer, ablation, re-entry vehicle design and shock layer ionization will be most useful.

## *Armament Control Analysts*

Experience in the synthesis of integrated fire control loops including the tie-in of sensing and guidance equipment is desirable. A strong background in target data sensing devices, particularly at optical wavelengths, is very helpful, as is experience with computers.

## *Systems Analysts*

Senior engineers and physicists to investigate such questions as: What are the optimum guidance systems for lunar and inter-planetary space flight; how are the system choices justified considering trade-off of choice in terms of cost effectiveness; what are the IR systems requirements for ballistic missile defense; what are the optimum signal processing techniques for inter-planetary telecommunications; what are the maintenance and logistic requirements for weapon systems; what are the requirements of manned space flight?

## *Instrumentation Engineers*

Involves the integration of advanced instruments into spacecraft such as Surveyor. Includes design for in-flight reliability; technical direction of instrument subcontractors; development of test programs and test equipment; and determining instrument interactions. Experience with subcontract procedures is also helpful.



PLEASE COMPLETE THE ATTACHED CARD so that we may become acquainted with your interests and qualifications. Or write: Dr. F. P. Adler, Manager, Space Systems Division, Hughes Aircraft Company, 11940 West Jefferson Boulevard, Culver City 53, California. We invite your inquiry and . . .

*creating a new world with electronics*

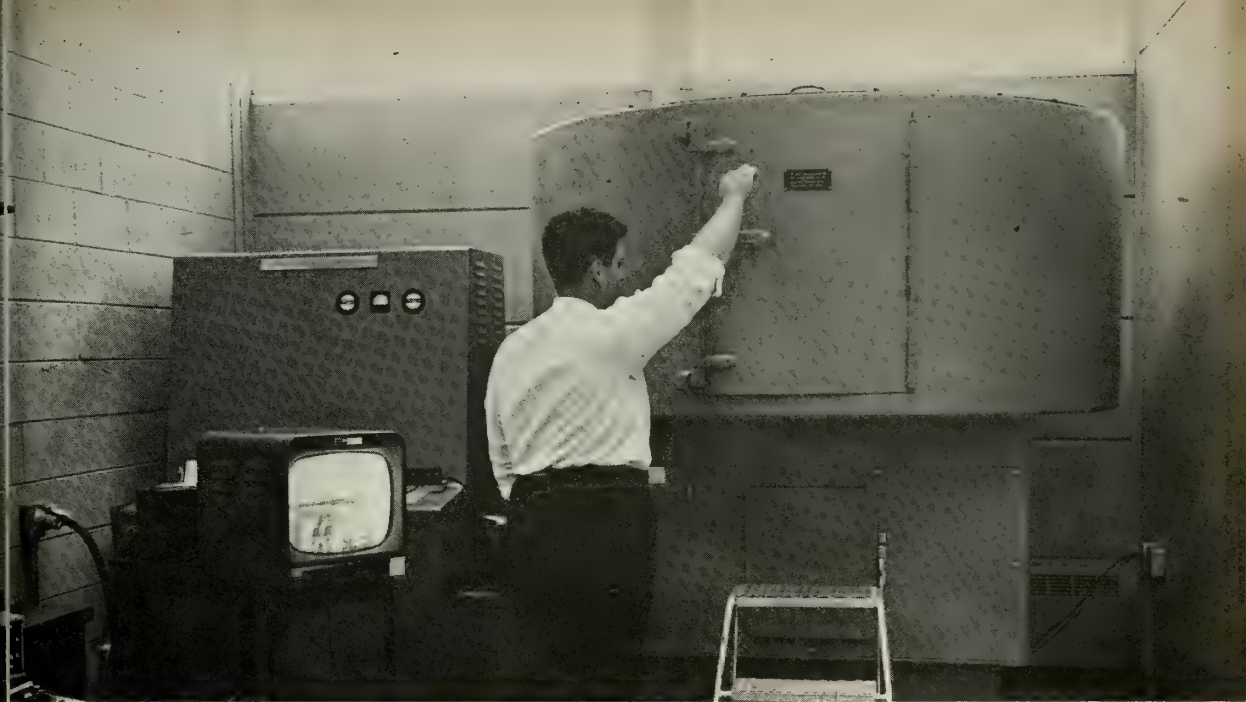
**HUGHES**

HUGHES AIRCRAFT COMPANY  
**SPACE SYSTEMS DIVISION**

*We promise you a reply within one week*

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*TIMER UNDERGOES acceleration in GTL centrifuge monitored by closed circuit television.*

fuzing and arming

## Warhead Timers Tested in Centrifuge

WARHEAD timing devices for several U.S. missile systems are undergoing severe acceleration tests in General Time Laboratories' centrifuge at Skokie, Ill.

Timers used in *Polaris*, *Talos*, *Nike-Hercules*, *Mauler* and *Sidewinder*, among others, are exposed to acceleration extremes up to 200 g's.

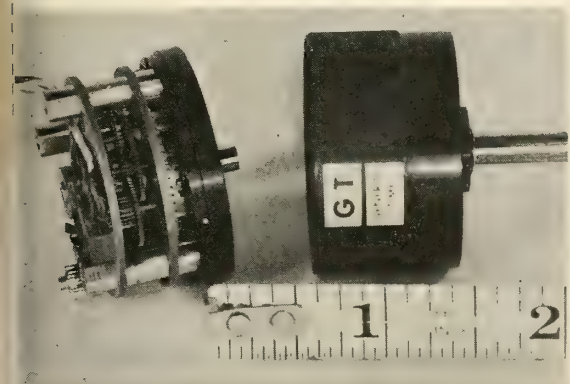
The environment effectively simulates missile launch and re-entry forces. Every timer destined for use in a warhead arming circuit is tested in the centrifuge. These timers, used primarily in ICBM systems, are set to activate the arming mechanism at predetermined g-levels.

Other timing devices, not made to activate at specific g-levels, are also tested in the centrifuge by standard production reliability testing ratios.

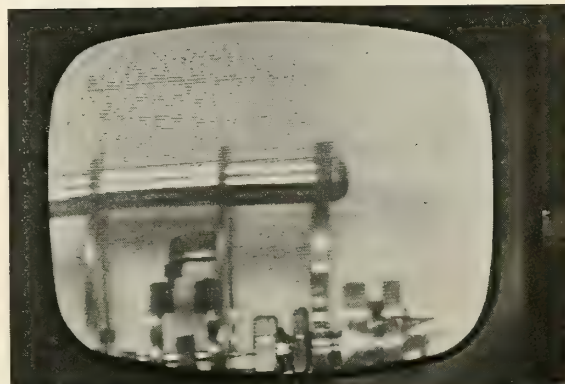
Duration of the tests can run from five minutes to one-half hour, depending upon which missile the unit is going into. Time needed for the centrifuge to reach peak acceleration speeds is not a factor, since the GTL unit moves from a stand-still to 140 g's in 10 seconds.

Monitoring of component behavior within the timer is accomplished through a closed-circuit TV installed within the centrifuge. A magnification device within the test setup enlarges the  $\frac{3}{4}$ -in. timer to fill a 20-in. TV screen.

GTL is developing additional space applications for these highly sensitive timing devices. Activation of specific systems within a manned space vehicle during periods of high crew stress could be accomplished with timers of this type. ❖



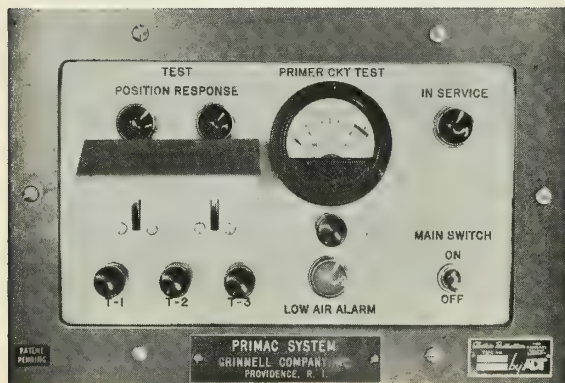
*TYPICAL TIMING DEVICE tested by GTL for missile makers.*



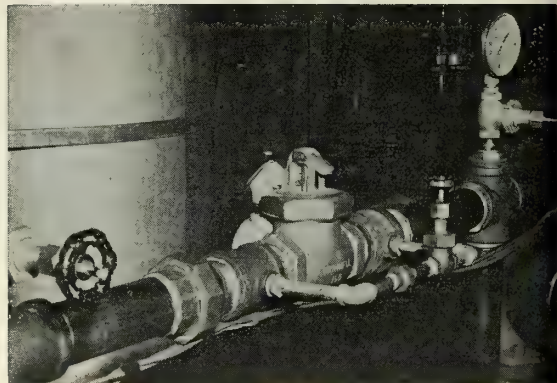
*MAGNIFICATION device fills 20-in. screen with tiny unit.*

# Quick-Acting Fire Fighter Perfected

*Grinnell system responds in milliseconds to fires in propellant processing plants; devices sense characteristic light*



*PRIMAC CONTROL panel houses equipment for testing system integrity without operating extinguishing phases.*



*EXPLOSIVELY ACTUATED valve in fired position. Latch holds piston closed; in operation, primer rests against latch*

A FIRE CONTROL system for propellant processing facilities—with millisecond response time between detection and douse—has been developed by engineers at the Grinnell Co., Inc.

Although much of the work in ultrahigh-speed fire protection has been done in connection with solid propellants, the principles involved and the system components can be used for any hazard requiring extreme operational speed, says C. F. Averill, manager, Special Hazards Dept.

Grinnell engineers tackled the two main phases of increasing the speed of a fire protection system—detection time and getting the extinguishing agent to the burning surface as fast as possible.

Conventional fire detection equipment depends on heat, smoke or some other product of the combustion. Grinnell took the one evidence of fire always present with high-energy fuels—light. The actuation system operates with a photo-sensitive cell.

- **Choosey cells**—Since many forms of light are normally present, the system had to be given built-in discrimination capability. Grinnell's Primac system uses a solid-state photosensitive cell limited to the infrared band of the spectrum.

In addition, the cell is mounted so that its field of view is directional.

The detection equipment is designed to operate only when the cell "sees" light above a certain intensity, making it possible to override ambient light conditions.

Averill says the detectors are usually arranged to operate in pairs and both must function before the system will operate. Ideally, each pair should be mounted opposite each other, preventing operation from reflections, flashlights and other normal sources.

The detector signal is carried to a solid-state amplifier in the control panel, which actuates the extinguishing section of the system. The panel can also test the integrity of the system without activating it.

Bringing the extinguishing agent to the fire necessitated the development of a fast-acting valve. In the case of solid propellants, water is used and Grinnell engineers perfected an explosively actuated unit. The valve body is designed to accommodate a piston-type closure. This piston is held in the closed position against water pressure by a latch resting on the piston stem. An explosive primer nestles next to the latch.

Firing the primer forces the latch off the stem, allowing the piston to rise and the valve to open. Since the supply and priming water fill all cavities of the valve, the first motion of the piston starts the water in motion. Action is

almost instantaneous.

- **Modified deluge**—Hazards requiring this type of quick-response protection also demand high water application per square foot for control and extinguishment. The entire hazard area should be flooded at one time. Normal systems usually employ open nozzles and empty piping leading to a deluge valve in the main supply. Filling these empty pipes in a fast system takes too much time.

Grinnell utilizes available spray nozzles with fitted caps, capable of holding priming water under a gravity head. The caps are blown off when line pressure is released into the system by the Primac valve.

While the Primac system can operate in the millisecond range, Averill says this can vary from installation to installation because of available water pressure, configuration of the piping and other normal factors. But experience gained during development work and current installations make possible the calculation of the operation time within reasonable limits.

The Primac system can handle auxiliary functions, initiating such processes as machine stoppage, fan and conveyor shutdown and sending alarms. The system can be integrated with an operation or process so that it is in or out of service as required. ■



# Small Firms Sell 1/3 of Electronics

**Stress on innovation and specialized, non-consumer products maintains share of market despite handicaps**

A FRESH LOOK at the electronics industry finds small firms prospering in today's market alongside several giant companies. The key to success: be unique.

Stanford Research Institute, in a survey conducted for the Small Business Administration, reports that companies with annual sales of less than \$10 million now have aggregate sales of some \$15 billion—one-third of the total market. (SRI estimates sales in 1960 for all electronic products, including intracompany and intercompany sales of subassemblies and components for re-manufacture, at \$15 billion; it estimates that actual industry output was \$10 billion.)

• **Off-beat accent**—Small firms are scoring heavily by concentrating on products with limited or underdeveloped markets.

Microwave devices and electronic test equipment are two areas in which smaller producers have been remarkably successful in meeting competition of much larger companies.

Most attractive marketing areas for small electronics firms are in the military and industrial segments of the industry, and in technologically specialized components.

For the military, there is a rapidly growing equipment market in reconnaissance and surveillance, countermeasures, checkout, detection, tracking and data reduction.

In the industrial market, small firms have been most successful in manufacture of testing and measuring instruments small in size and high in technical complexity.

The SRI study points out that innovation is vital for small electronic firms.

Because most electronic items are produced in relatively small quantities, expensive, automated equipment is less important than it is in other industries. SRI says the correspondingly lower

capital requirements make it possible for small firms, starting on small budgets, to compete effectively with industry giants. Highly skilled labor, for both design and production—not large and expensive plants—is the key commodity in all electronics manufacture.

• **Still tough**—The study does not minimize the problems of small companies in trying to compete across the board with larger firms.

In most instances, small firms are able to compete on a basis of quality or uniqueness of product rather than price. This, however, requires a high investment in company-funded R&D. Also, SRI reports, it often means staying out of price-conscious consumer markets.

Development of effective management is another problem for smaller companies, which cannot in general afford to retain the management specialists who serve larger organizations. Often, the highly trained technical person who starts a new business has only marginal experience in the economic aspects of business operations. This problem becomes acute as a company begins to experience the high growth

rate typical of many organizations in the industry.

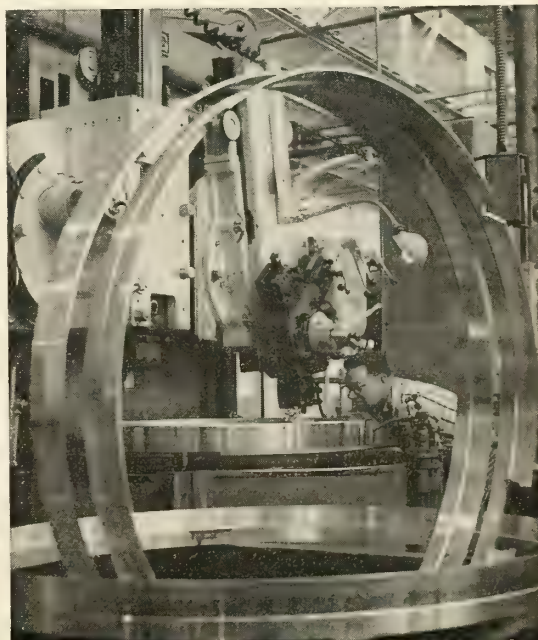
Still another headache may develop in raising capital. Successful small electronics firms often grow so rapidly that all of their funds are tied up in inventories and accounts receivable. At this stage of development, financial experience is invaluable for providing capital for further expansion.

SRI underlines the industry's increasing complexity as one of the negative factors for the future. On the positive side, investor interest in electronic firms has made it less difficult to raise capital than in the past. In addition, the industry has not changed basically and is, for the most part, still conducive to small quantity production, with relatively simple equipment, in small non-integrated facilities.

The SBA has found data on the electronics industry very scarce despite the industry's tremendous growth. It sponsored the SRI study in an effort to establish new programs which would aid small business men in filling and expanding their role in the nation's economy. ■

## Rings for the Minuteman

*MACHINIST at Ryan Aeronautical Co. operates one of nine big turret lathes used to machine separation rings for AF's Minuteman solid-fueled ICBM. Ryan's San Diego plant is producing the rings in large quantities, made of aluminum alloy and ranging from 37½ to 65 in. in diameter, under subcontract to Boeing, Minuteman prime contractor.*



# Award spells \$1-2 billion in sales by 1965 . . .

(Continued from page 15)

Storms said only a small amount of outside recruiting will be necessary in assembling the technical staff for the project. Employment at the division now stands at about 7800. This is expected to expand only slightly.

• **X-15 lessons**—When Storms moved into the presidency of the division in December, 1960, he took with him a good portion of the team which engineered and built the X-15. More members of this team will be shifted to Downey as the X-15 phases out and *Apollo* phases in.

Storms believes that the experience of the X-15 team—which he describes as “a real gung-ho outfit”—was one of the major factors in North American’s winning of the award.

“They’ve been through this once,” he said. “They know what to look for and are well-seasoned.” The division president pointed out that the designers and engineers on the X-15 project have worked together nearly 10 years and that many of them have been with North American as long as 20 years.

“We don’t have to go out and recruit 500 engineers off the street who have never seen each other,” he said.

Much of the remainder of the NAA team being assembled for the *Apollo* project will come from other North American divisions. Structures people are being shifted from the Los Angeles division and a number of high-caliber personnel already have been transferred from the Rocket-dyne division.

• **Managers**—The NAA team will be headed by John W. Paup as project manager. Paup will be in complete charge of the program, Storms said.

“He will not be an adviser or a staff official but a line officer,” Storms said. “He will give orders, not suggestions.”

Paup, formerly an Air Force colonel in electronic countermeasures, worked as electronics manager on the B-70 at North American’s Los Angeles division. He left to join Sperry-Utah at Salt Lake City and then rejoined NAA to work on the *Apollo* proposal.

Assistant to Paup will be former West Pointer Milton Sherman, who has been with the Downey division for some time.

Chief engineer on the North American *Apollo* project will be Charles Feltz, former project engineer on the X-15.

“It will take a little while to get everybody in place,” Storms said, “but the team should be nailed down by the first of the year.”

Asked how North American planned to tackle management of the prime contract in the manned lunar landing program, Storms reply was typically brief: “Just professionally.”

Details of the management and subcontracting will be worked out with NASA in the talks which will begin this week. These are expected to take place both in Washington and on the West Coast.

“Before, we were suggesting to them,” Storms said. “Now they are going to tell us what they want.”

• **Them as has . . .**—The award to NAA came in the face of the fact that North American already stands in first place as NASA’s largest industrial contractor. It is third on the Department of Defense military contracting list.

The Space and Information Systems Division itself accounted for more than 9% of NAA’s record \$1,262,333,263 in sales in Fiscal 1961, which ended Sept. 30. Division sales of \$108,144,000 were up from the Fiscal 1960 sales figure of \$82,081,000.

North American’s overall net earnings were \$27,750,137 for the fiscal year, up from \$23,394,548 in Fiscal ’60. Non-

aircraft programs accounted for some 62% of the total sale in Fiscal ’61.

The award is expected to pour between \$1 billion and \$2 billion in sales into North American over the next five years.

• **Schedule set**—Space agency officials declared that final design of the spacecraft will be determined in six months, with production to begin in eight to twelve months. The first representative spacecraft will roll off the assembly in 1964 and be sent on earth orbital missions late in that year.

That schedule, the official said, will be ready for manned lunar landing in 1967.

This and other new information on the spacecraft’s systems and configuration were revealed shortly after NASA announced the selection of NAA to head its industrial team.

Initial phase of the contract will be worth \$400 million but estimates of the total cost of the spacecraft program run from \$10 billion to \$15 billion.

The contract—to be signed before the end of the year—will also set the specifications for the lunar landing module and orbiting laboratory modules.

Massachusetts Institute of Technology Instrumentation Laboratory has already been selected as the associate contractor for the spacecraft’s guidance and control system. An industrial firm will be selected by NASA to produce the systems.

• **Rough shape**—NASA officials refused to disclose specific figures on the spacecraft’s weight or dimensions. They declared that this information is classified and its disclosure would provide the Soviet Union with key facts about the state of U.S. space technology.

One official said, however, that the spacecraft will weigh between 100,000 and 150,000 lbs. It will be 15 ft. to 20 ft. high and about 60 ft. long. Its command and service module will be about 12 ft. to 15 ft. in length and diameter. The lunar landing (Propulsion) and orbiting laboratory module will be about 30 ft. long.

Other important information revealed includes:

—**Materials:** A plastic ablation material (like fiberglass) will be applied over a double-shell honeycomb-type of structure which will be constructed of either aluminum or stainless steel. The structure will be a monocoque type which does not rely on internal pressurization to sustain itself.

—**Propulsion:** The lunar landing module will have a capability of 50,000 to 75,000 lbs. in terms of thrust. It will be powered by hydrogen/oxygen and require throttleable capability. Thrust vector control will also be needed.

NASA has chosen to use multiple engines—several large ones with fixed thrust and smaller ones with variable thrust.

The smaller engines will take care of the terminal phase of the lunar landing, and will be throttleable from plus or minus 1/6 of the spacecraft’s weight at lunar touchdown.

The lunar landing module must also be capable of hovering and moving laterally.

—**Abort and lunar takeoff propulsion:** An earth-storable hypergolic system similar to the current *Agena* launch vehicle will be used. It will also need small propulsion for attitude control, which will also use storable hypergolic with about 25 lbs. thrust.

—**Power:** Current plans are to use hydrogen/oxygen fuel cells. Because of the time factor, chemical batteries will be used in the early earth orbital flights.

—**Guidance and control:** These are being developed at MIT. It is certain, however, that a lightweight computer, a stabilized platform, and an integrated accelerometer are required.



# The First OAO

(Continued from page 17)

angular momentum transfer from the vehicle to the wheels. Two unloading systems are employed with the OAO to prevent wheel rotation rates from becoming excessive.

The first method employs gas jets arranged so that a torque will be provided about the proper control axis when any of the wheels reach a threshold speed. This will serve to reduce wheel speed to below pre-set limits.

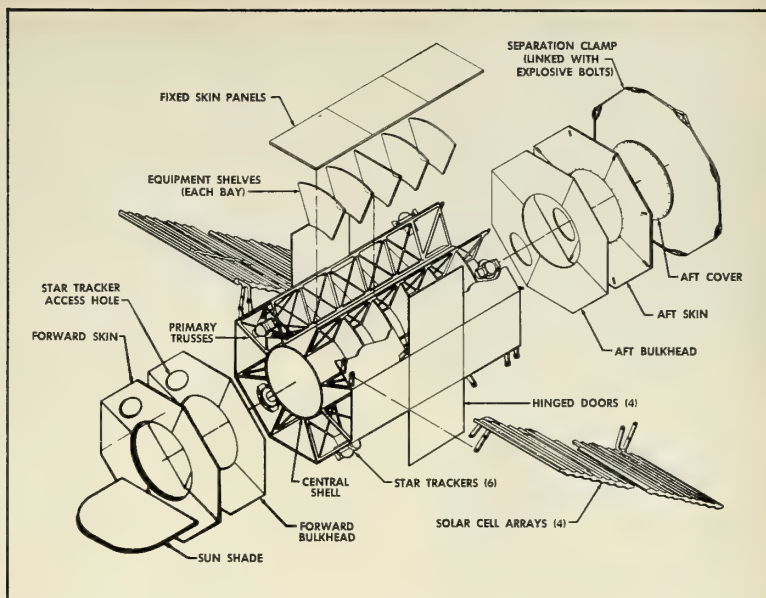
The second system available will employ magnetic unloading to acquire the necessary torque effect. This is the first known application of this principle to actual satellite operation. The torque will be provided as a result of the interaction between the earth's magnetic field and current carrying coils mounted in the vehicle.

This system promises high reliability since no moving parts are required and also has the distinct advantage of continuous reduction of the angular momentum of the wheels.

• **Design objective**—The guiding objective behind the design for OAO was the creation of a standardized spacecraft capable of mounting one or more separate astronomical experiments and easily reconfigured to meet changing scientific needs.

The OAO's eight-sided shell, measuring 116 in. long and 80 in. wide, contains a hollow shaft longitudinally through its center for insertion of mirror devices with up to 40-in. diameters.

The structure has been designed for extreme rigidity and minimum thermal distortions in order to maintain the precise orbital alignment requirement for performance of its mission. Aluminum is used as the basic structural material,



*BASIC OAO STRUCTURE was designed to provide craft easily adaptable to future scientific missions and capable of housing an assortment of instruments.*

but several key components are mounted with titanium.

Primary power supply for the OAO is generated by a fixed array of silicon solar-cells mounted in a saw-tooth pattern on two paddle-like structures attached to two sides of the satellite. These paddles are folded along the sides during launch and erect to in-flight position after booster burn-out.

Four r-f links are available for OAO tracking, radio command, and telemetering purposes.

Two of the links are for telemetry use, a wide-band net for transmission of analog and digital data at rates up to 50,000 bits per sec, and a narrow-band link for handling other digital information at speeds up to 1000 bits per sec.

Radiation patterns for the various communications systems are designed to provide as much spherical coverage as is possible in order to maintain favorable communications with ground stations despite satellite orientation.

Programed commands to OAO will originate from a central control facility at the Goddard Space Flight Center in Maryland

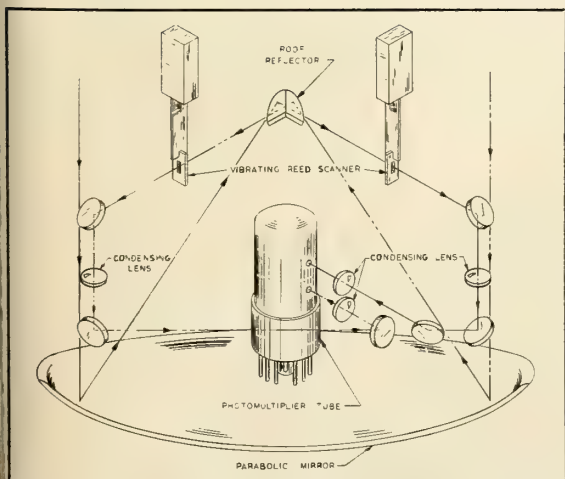
and will be broadcast via specially equipped Minitrack stations.

Another major feature of the OAO is its ability to react to ground commands both to the experimental package and to the spacecraft. An OAO control center receives coded ground signals, decodes, and distributes the message to the proper system within the observatory. Delayed commands can be stored within the unit's command storage area until the correct elapsed time.

A magnetic-core type data storage facility with a 100,000 bit capacity is also provided for storage of data on experiment and spacecraft status which is periodically transmitted to earth, and also for data accumulated while the satellite is out of line-of-sight range with ground stations. (M/R, June 12, p. 26). These commands can serve to activate a number of OAO systems and also act to reorient the spacecraft.

Major subcontractors teamed with Grumman in OAO effort include General Electric's Missile & Space Vehicle Division, IBM's Space Guidance Center, and the Westinghouse Air Arm Division. GE is providing several stabilization and control components and subsystems.

Kollsman Instrument Co. has been subcontracted by GE to produce the star trackers, and Ball Bros. will turn out the solar trackers. IBM is supplying the OAO control center and most of the data storage and processing subsystems. WEC is designing and manufacturing the special ground operations equipment for the three minitrack stations and ground control station. ❖



*OPTICAL SYSTEM for the six star-trackers deployed around the OAO shell is shown in this schematic.*

# National Command and Control System

(Continued from page 13)



**PRESIDENT** C. W. Halligan, former Director of Military Engineering at Bell Telephone Laboratories, was named president of Mitre when it was set up in 1958. The 59-year-old executive had been associated with a wide variety of programs at AT&T, Western Electric and BTL since 1926. These included SAGE, the DEW Line, and early development of U.S. air warning systems. Halligan holds 12 patents in the communications field. He was graduated from Bucknell in 1923, received a Master of Science degree there and taught at the Bucknell College of Engineering.



**VICE PRESIDENT** Robert R. Everett joined Mitre as Technical Director in 1958, moved up to become Vice President-Technical Operations a year later. The 40-year-old electrical engineer became associated with the pioneer Project Whirlwind computer program two years after receiving a Master of Science degree from MIT. He received his bachelor's degree from Duke. In 1951, Everett became associate director of the MIT Computer Laboratory, then moved with the organization when it became part of Lincoln Laboratory. In 1956, he became head of Lincoln's Division 6, which designed the SAGE system.



**ASSISTANT VICE PRESIDENT** John F. Jacobs, formerly Mitre's Systems Technical Director, was named Assistant Vice President in October. Jacobs joined Mitre in 1958 after spending six years at MIT working on system engineering for air defense projects. In 1955, he headed a project group at Lincoln Laboratory; later he became an assistant division head, then an associate division head. During this period, he served as a liaison engineer with industry for SAGE. Jacobs, who is 38, was graduated from Illinois Institute of Technology in 1950. He received a Master of Science degree from MIT in 1952.



**SYSTEMS PLANNING AND RESEARCH DIRECTOR** Charles A. Zraket moved to Mitre in 1958 after working for five years at MIT's Lincoln Laboratory primarily on SAGE. He was a Section and an Associate Leader in the design and development of SAGE and later headed the Advanced SAGE Program Development Group. He was Mitre's Associate Technical Director for Command and Control Systems until last month, when his new Directorate was established. Zraket, who is 37, was graduated from Northeastern in 1951. He received a Master of Science degree from MIT in 1953.

gramed long in advance and other vastly complicated electronic systems are needed.

However, the Air Force lacks a sufficient supply of highly competent electronics experts to provide itself with objective technical support in this field. Its answer to the problem is Mitre.

• **"A little bit more . . ."**—This answer is sharply questioned and resented in many sectors of private industry. Congress, in turn, has reflected this reaction.

Halligan and many Air Force officials feel that this reaction comes from misunderstanding the role of Mitre. It may also be based in some cases on being thwarted in establishing a design requirements for one's own hardware.

"The only thing we take away from private industry," Halligan said a few days ago while sitting in his Mitre office at Bedford, Mass., "is the part of the job where objectivity and its relationship to all other systems is important."

"Most reasonable people see this. A lot of industry officials drop by to talk to me about one thing or another, and sooner or later they ask: 'What are you going to do to us?' And, invariably, they go away very much relaxed."

Halligan grinned and took a sip of coffee from a cardboard cup. He was in his shirtsleeves and he talked with the informal air of the scientist-administrator.

"To make these systems succeed," he said, "you must have one boss, one central point of control. That is ESD. But they must have one technical source of advice to assist them in arbitrating technical questions between two contractors."

"But, if ESD is to rely on this one source, this means he must be damn good. He must know a little bit more than anyone else."

The Air Force sees Mitre's role in very much the same way. It regards Mitre as a key part of its in-house capability.

• **Sharp changes**—Together ESD and Mitre in the last several years have radically changed much of the Air Force's thinking about command and control systems.

The pivotal factor, the significance of which has become increasingly clear, the type of electronic command and control system installed greatly determines what kind of war can be fought.

National policy—the planned missiles and rockets, December 4, 1961



tary job—is built into the system. Therefore, a definition of the military job must precede the system rather than the other way around, as has been done many times in the past.

The systems that exist today are first class examples of the problem:

Communications and command posts are generally vulnerable. Computers are generally programed to cope with a retaliatory strike. The ability to maintain overall command from the top for any length of time that can be measured in more than hours is in doubt.

This system—or, more accurately, the group of not necessarily integrated systems—is designed to commit U.S. strategic forces in a reflex strike in accordance with the national policies of the 1950's. This group of systems was not designed to fight a nuclear war over a long period of time, to cope with the unexpected, to be ready to fight the various possible wars now envisaged by some planners in the Kennedy Administration.

• **Spelled out**—Discussing some of the current problems and needs of command systems, John F. Jacobs, Mitre assistant vice president for technical operations said recently:

—A single, continuous operational line of command from the highest level of national authority to any weapon is essential. There must also be an emergency political line of succession to

assure survival of national decision-making capability. Furthermore the people in the emergency line of succession must be thoroughly familiar with the war plans and procedure and be in contact with their military counterparts.

—The military system must be capable of selective and deliberate response to attack—a response not solely dependent on warning. There must be rapid but considered decision-making capability and rapid execution of decisions. This requires pertinent situation assessment data, data processing and reliable communications.

—The national decision-making apparatus must have a survivable trans-attack capability. There must be continuous manning of primary and alternate centers to assure the smooth transition from pre-attack to trans-attack to the post-attack phase of war.

—The top command must be able to maintain a continuous view of both the enemy and U.S. forces. And at least some sensors and communications to forces must be able to survive repeated attacks.

• **Evolutionary**—Many of these requirements already are being applied in designing the Air Force's new command and control systems.

However, the approach that is being taken is evolutionary rather than revolutionary.

"Our goal," Halligan has said, "is to begin with what the military has and give them over a period of years what it needs. This is far better than giving the military nothing new for five years then dumping something in its lap that no one knows how to operate."

By taking this approach, there are also the advantages of achieving growth through experience with new equipment and of being able to introduce new requirements in line with developing policies.

The very meaning of "L" system is changing.

"In the beginning these things were pretty well separate," an Air Force official said recently. "They grew like Topsy. But now the 'L' system is only a convenient package, a management device for handling an integrated part of the whole which is steadily evolving."

But even with the evolutionary approach the difficulties in devising the electronic command and control systems needed are tremendous.

As Zraket explained it candidly:

"With a manual system a commander could change what he was going to do day to day. With the electronic systems, we have in the past tried to define two to five years ahead of time how you are going to fight a war in explicit detail.

"The problem is you really can't do this. We need something much better." ❖

## Command and Control Systems

### Command Systems

**425L—NORAD COMBAT OPERATIONS CENTER:** A system which collects, processes, and displays data to assist the Commander in Chief, North American Air Defense Command (NORAD) in commanding and controlling his forces. Prime contractor—Burroughs. Status—under implementation.

**465L—STRATEGIC AIR COMMAND AND CONTROL SYSTEM:** A system which collects, processes, and displays data to assist the Commander in Chief, Strategic Air Command (SAC) in commanding and controlling his forces. Prime contractor—ITT. Status—development.

**473L—AIR FORCE CONTROL SYSTEM:** A data processing and display system to assist USAF Headquarters in making command decisions. Prime contractor—IBM. Status—design.

### Control Systems

**416L—SAGE AIR DEFENSE SYSTEM:** A semi-automatic area air weapons control and warning system for detecting, identifying, tracking, and providing weapon intercept control capability against air-breathing missiles and aircraft attacking North America. Systems management—Western Electric. Status—under implementation.

**412L—AIR WEAPONS CONTROL SYSTEM:** An overseas theater tactical air weapons control and warning system. Prime contractor—GE. Status—development and production.

**431L—TRAFFIC CONTROL AND LANDING SYSTEMS:** A program to develop and produce air traffic control equipment—landing and terminal systems—essential to the Air Force. Status—under implementation.

### Intelligence Systems

**438L—INTELLIGENCE DATA-HANDLING SYSTEM:** A system for high-speed processing of world-wide intelligence data. Prime contractor—IBM. Status—active.

**466L—ELECTROMAGNETIC INTELLIGENCE SYSTEM:** A world-wide system for collecting intelligence by electromagnetic means and processing for transmission to users. Prime contractors for study—RCA/IBM. Status—study and preliminary design.

### Warning Systems

**474L—BALLISTIC MISSILE EARLY WARNING SYSTEM:** A system to provide early warning of a mass ICBM attack on the North American continent from the north. Prime contractor—RCA/Western Electric. Status—under implementation.

**413L—EXTENSION OF DEWLINE:** A distant warning system for detecting hostile air-breathing threats approaching the North American continent from the north. Prime contractor—Western Electric. Status—under implementation.

**477L—NUCLEAR DETECTION AND REPORTING SYSTEM:** A system to provide NORAD and other military and civilian agencies with essential information on nuclear detonations occurring within the NORAD area of responsibility. Status—study.

**496L—SPACE TRACK:** A system for detecting, tracking, identifying, and cataloging orbiting objects. Prime contractor—Aeronutronic. Status—under implementation and study.

### Support Systems

**480L—AIR COMMUNICATIONS SYSTEM:** A system to insure inter- and intra-system communications services to support global Air Force operations. Prime contractor—Communications Systems Inc. Status—study and preliminary design and implementation.

**433L—WEATHER OBSERVATION AND FORECASTING SYSTEM:** A global semi-automatic electronic system for observing, forecasting, and processing weather information. It is being developed in coordination with FAA and the U.S. Weather Bureau. Prime contractor—United Aircraft. Status—development.

**PROJECT VANGUARD**, Kurt R. Stehling, Doubleday & Co., New York, 312 pp. \$4.50.

America's attempted answer to the two orbiting *Sputniks*—*Vanguard Test Vehicle 3*—reached its final countdown almost four years ago, on Dec. 6, 1957. In an inferno of burning propellants the vehicle toppled over, carrying a big hunk of America's scientific prestige with it.

The author tells the story behind this dismal failure—right up to the glittering success which occurred on St. Patrick's Day, 1958. As former head of Project *Vanguard* propulsion, he is able to give a first-hand account.

But the story is a far bigger one than the history of Project *Vanguard* alone. It is one familiar to every engineer who's ever had anything to do with the thousands of details that go into building a missile, and who knows how just one frozen valve, one short circuit, one erratic instrument can put millions of dollars and months of work to a fiery end.

Yet it is a story that has seldom been told nor, to my mind, told as well as it is here. W. B.

**HANDBOOK OF ASTRONAUTICAL ENGINEERING**, H. H. Koelle, Editor, McGraw-Hill Book Co., New York, 1848 pp., \$27.50.

Many of us have looked forward to seeing this handbook, expecting that like others from the same publishing house, it would have inherent editorial excellence. Alas, in this instance merit seems to be skipping a generation.

Its most serious lack is in concept. Did the editors want a book that, like Marks' *Mechanical Engineers' Handbook* in its field, would be the astronautical engineer's closest professional companion? If so, why are there pages devoted to the social impact of space activities but none to mathematical tables—or for that matter, to any mathematics? And why are 12 pages used to give the full decimal classification of astronautics—which a librarian would find invaluable—while only a few words are provided on the subject of fuel cells, the hottest APU items in recent years.

An entire chapter is devoted to relativistic rocket mechanics, which has application only when a rocket's speed is a significant fraction of the speed of light; yet there is scarcely a mention of rocket packaging and transport on earth, and only a brief mention of the design of vehicles for use on the moon.

Nevertheless, the book's nearly 2000 pages contain some very good material. Among the best is the chapter on Astronavigation, which in classic handbook style gives the engineering background for a problem solution, and then proceeds to illustrate method by practical examples.

The Astrodynamics section of the book is excellent. For example, the aerodynamics portion starts with the fundamental Newtonian equations and, within the space of a few pages, carries the reader

easily into the basic aerodynamics in rarefied flow. From here, the steps to "free-flight trajectories close to celestial bodies" are quickly taken but clearly marked; the data given are useful and practical—the mark of an adequate handbook.

What this critic objects to most is the insertion of material of limited engineering interest to the apparent neglect displacement of material of obvious high interest. It seems unrealistic to devote a mere 3/4 pages to conversion factors—placed at the end of the book almost as an afterthought—when these are the factors probably most frequently needed by engineers. Moreover, the editors seemingly did not even bother to update these factors from the Marks handbook from which they were extracted. There's hardly a modern conversion factor in the batch—not a mention of the astronomical unit, barns, atomic mass unit, electron-volt, roentgens; but there are conversions of barrels to gallons, U.S. gallons to imperial gallons, and long tons to kilograms.

The handbook is worth the price to those in the space and missile field. But it could have been worth much, much more. W. B.

**PROGRESS IN VERY-HIGH-PRESSURE RESEARCH**, Proceedings of an International Conference held at Bolton Landing, N.Y., June, 1960, edited by F. P. Bundy, W. R. Hibbard, Jr., and H. M. Strong, John Wiley & Sons, N.Y. 314 pp.

Equipment and techniques, structures of materials formed under high pressures, and behavior of matter under high pressures are covered in the volume.

The problem of absolute-pressure calibration receives considerable attention and many interesting optical, electrical and magnetic changes in materials resulting from decrease of interatomic, or intermolecular, distances are described.

**PHYSICAL CHEMISTRY IN AERODYNAMICS AND SPACE FLIGHT**, Edited by A. L. Myerson and A. C. Harrison, Pergamon Press, New York, 288 pp.

Incorporates in one volume the papers presented at the Conference on Physical Chemistry in Aerodynamics and Space Flight held at the University of Pennsylvania, September, 1959. The meeting was sponsored by GE's Missile and Space Vehicle Department and the Air Force Office of Scientific Research. The papers are subdivided into sections corresponding to the original sessions and a short review of the special session discussing the status of plastic pyrolysis in ablation is included.

**MEDICAL AND BIOLOGICAL ASPECTS OF THE ENERGIES OF SPACE**, edited by Paul A. Campbell, Columbia University Press, New York, 491 pp., \$10.

The papers in this book—written by recognized experts in their fields—delineate

the energies of space, describe their potential applications, and explain their dangers for man. Among the subjects discussed are: solar and cosmic energies, magnetic fields, radiation sources within the spacecraft, gravitation, energy conversion, aspects of illumination and photosynthesis, shielding, chemical and biological protection, and biological implications of electromagnetic and particulate radiation.

This volume was conceived and developed to bring together the special knowledge of workers in the medical, biological, astrophysical and engineering sciences with respect to space energies, their conversion and use. It has been compiled from papers delivered at a symposium held late last year, sponsored by the School of Aerospace Medicine of USAF's Aerospace Medical Center at Brooks AFB, Texas. The symposium was arranged by Southwest Research Institute of San Antonio.

**DIGITAL COMPUTER FUNDAMENTALS**, Technical Training Department, Military Service Div., Burroughs Corp., Radnor, Pa., 520 pp., \$5.50. (Checks should be made out to the Burroughs Corp. and sent to E. S. Junker, Technical Training Dept.)

This book was written as a reference for the seven-week "General Computer Fundamentals Course" given by the Military Field Service Div. of the Burroughs Corp. It is also an excellent text for the learn-it-by-yourself student.

Covering the fundamentals of electronic circuits and the logic of many different digital computers and electronic data processors, the book is designed to prepare the prospective computer technician, engineer, and programmer for more advanced computer concepts. For comprehensive coverage of the many types of logical circuits used in computers, the book treats in detail five basic logic systems. These are the vacuum-tube logic system and four types of transistor logic systems: direct coupled transistor logic, resistance transistor logic, resistance capacitance transistor logic, and current mode logic.

**THE ELECTRO-EROSION MACHINING OF METALS**, A. L. Livshits, Butterworth, Inc. Washington, D.C., 126 pp., \$5.75.

The volume covers a complete and up-to-date description of the state of the technique, technology and industrial uses of electro-erosion machining. Prime emphasis is on electro-pulse methods, which have better technical and cost characteristics and a wider field of application than the electrosark. Among the various uses of electro-pulse machining, the author describes the more thoroughly investigated copy drilling applications, which have proved the most difficult to get into operation but the most versatile in technological capabilities. There is an introduction of definitions and classifications designed to further work out the basic ideas in this electrotechnology.



**PROGRESS IN POWDER METALLURGY**, Volume 17, Metal Powder Industries Federation, 60 E 42nd St., N.Y. 17, N.Y. 195 pp., \$12.00.

The volume covers advances in powder metallurgy application described at the 17th Annual Technical Meeting of the Metal Powder Industries Federation. A partial list of subject matter includes the manufacture of beryllium sheet from powder, high-strength sintered titanium parts, influence of fabrication techniques on electrical and magnetic properties of sintered metals and new developments in furnaces for high-temperature sintering. A special symposium covering powder metallurgy tooling and compacting techniques is also treated.

The Israel Program for Scientific Translations has recently published two technical works by Russian authors for the National Science Foundation and NASA. Both volumes are available from the Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C.

**Random Processes in Electrical and Mechanical Systems**, by V. L. Lebedev, deals with stationary and non-stationary random processes in linear systems, and in inertialess non-linear systems which have either one or several inputs and outputs. The application of the mathematical methods expounded is illustrated by practical examples related to various physical and engineering problems.

**Non-Linear Theory of Thin Elastic Shells**, by Kh. M. Mushtari and K. Z. Galimov, deals with the general theory of elastic shells under large displacements and small deformations, and with the application of the theory to the study of the stability and large deflections of parts of shell structures.

**KINETICS, EQUILIBRIA AND PERFORMANCE OF HIGH-TEMPERATURE SYSTEMS**: Proceedings of the First Conference, Western States Section, The Combustion Institute, Edited by G. S. Bahn and E. D. Zukoski, Butterworth, Inc., Washington, D.C., 255 pp., \$12.50.

The volume is primarily aimed at those engaged in performance calculations for high-temperature systems. Subject matter includes input and output thermodynamic data per se, computer programming for output thermodynamic data and for standard engine performance parameters, combustor and exhaust nozzle design.

**NON-LINEAR THEORY OF THIN ELASTIC SHELLS**, Translated from the Russian by J. Morgenstern, J. J. Schorr-Kon and PST Staff, Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C., 372 pp., \$3.75.

The book deals with the general theory of elastic shells under large displacements and small deformations, and with the application of this theory to the study of stability and large deflections of parts of shell structures.

**HIGH-STRENGTH STEELS FOR THE MISSILE INDUSTRY**, Edited by H. T. Sumison, Lockheed Missile and Space Div. Order from the American Society for Metals, 276 pp., \$12.00.

The volume includes the papers and missiles and rockets, December 4, 1961



## New Way to Locate Targets

*LOCKHEED'S Missile and Space Division will have in operation late this month a radio telescope employing a new method of locating airplane targets. The heavy 85-ft. parabolic dish of the new structure remains stationary, with focus achieved through movement of a small, steerable feed antenna suspended over the dish.*

one written discussion presented at the Golden Gate Metals Conference, February, 1961. A majority of the papers are devoted to the many aspects of solid-rocket motor chambers. Others cover fabrication problems, stress corrosion, fracture theory, metallurgical tests, a cobalt-containing high-strength steel developed by the Mellon Institute and future applications for high-strength steels.

**PLASMA ACCELERATION**; The Fourth Lockheed Symposium on Magnetohydrodynamics, Edited by S. W. Kash, Stanford University Press, 117 pp., \$4.25.

The author has collected a number of papers covering recent experimental and theoretical results concerning the principal means of accelerating ionized material for propulsion—including pulsed magnetic plasma accelerators and d-c electrostatic ion-electron accelerators. Various geometries are considered, as well electrodeless and crossed-field configurations. Scaling relations for devices employing fully ionized gases are derived. Detailed information is given on the problems involved and the obtainable thrust specific impulses and efficiency.

**ROCKET PROPULSION TECHNOLOGY**, Vol. 1. Plenum Press, Inc. New York; 370 pp., \$12.50.

The book contains the proceedings of the Rocket Propulsion Symposium, held at Cranfield, England, Jan. 6-7, 1961. All papers read as well as formal discussions held are included.

Reliability and controllability in rocket

engines are the chief topics dealt with. In addition, several valuable papers on other areas of rocket propulsion are presented—many describing new experimental and test techniques such as instrumentation techniques, pump efficiency measurement, solid propellant internal ballistics, packaged liquid propellants, and hydrogen as a propellant.

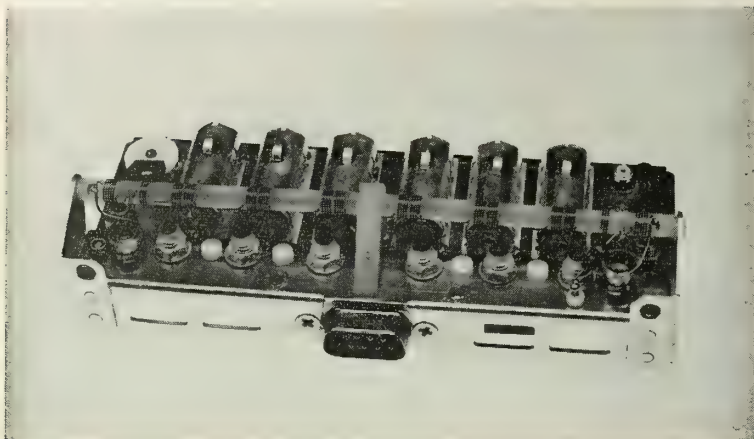
**SALES MANAGER'S GUIDE TO SOUTHWESTERN BASES**, compiled by the Los Angeles Chamber of Commerce. \$1.50 to members of LA Chamber of Commerce, \$3 to non members.

The Guide is a marketing directory to southwestern military establishments. Bases are located by operating service and every purchasing and contracting office is listed by title, location, address and phone number. Also included are suggestion on how best to approach these buying influences, and sources for additional support information on selling to the military.

**HANDBOOK FOR TECHNICAL WRITERS**, R. C. Tracy and H. L. Jennings, American Technical Society, Chicago. 134 pp., \$3.50.

Primary attention in this handbook is directed toward report writing. Since government agencies and government contractors are the two primary sources of technical documents the book is oriented towards these organizations.

The book examines the function of report writing, then deals with elements of technical documents, technical writing style and security requirements.



## New Product of the Week:

### Low-Cost Broadband VHF Amplifier

THE MOTOROLA INC. Systems Research Laboratory is marketing the first low-cost, MIL-E-5400 Broadband VHF Amplifier. Designated Model LPD01, the miniature amplifier weighs less than 6 oz. and occupies a space of less than 12 in.<sup>3</sup>

With exceptional broadband response, the rugged unit provides 9 db gain over the entire 30 mc to 300 mc frequency range. The amplifier is designed as a plug-in module that can be readily cascaded ahead of a tuned receiver, or used as a crystal video receiver by employing a crystal detector.

Suitable pulsing of the amplifier's bias line can convert a CW signal into a pulsed RF signal, and enable RF gating or receiver blanking functions. Control of the pulse amplitude will provide variable attenuator characteristics, and instantaneous automatic gain control operation for RF limiting applications.

Circle No. 225 on Subscriber Service Card

## Tiny Power Packs

Electronic Research Associates, Inc., is marketing a line of subminiature, solid-state high-voltage d-c power supplies. These exceptionally compact self-contained units provide either regulated or non-regulated high voltage outputs utilizing solid-state devices and magnetic components in special circuitry. Units utilize balance transistor keyers to con-

vert the input power to a high-frequency source. Regulation is accomplished at low voltage levels by control of the characteristics of the transistor keyers.

Circle No. 226 on Subscriber Service Card

## Silicon Controlled Rectifiers

The Industry's first Silicon Controlled Rectifier is available from Solid State Products, Inc. Packaging techniques newly developed by SSPI make this miniaturization possible with no sacrifice in sensitivity, cutoff characteristics, or inherent reliability. Two-mA triggering, d-c ratings to 200 volts and 350 mA and with pulse capability to 10 amperes are available in both conventional outline and a radically new in-line configuration for welded modules and printed circuits.

Circle No. 227 on Subscriber Service Card

## 300,000-psi Bolts

Tension and shear bolts rated at 300,000-psi tensile strength are being produced by Standard Pressed Steel Co. The 300,000-psi development is actually a fastening system rather than

just a bolt, since SPS has simultaneously developed mating locknuts, load-bearing and preload indicating washers and a high-strength socket wrench. Use of these allied components is essential to insure development in initial tightening of full potential strength of the bolt. SPS is now producing both tension and shear bolt versions in diameter sizes #10 through 7/8 in. and shear bolts in sizes #10 through 3/4 in. A complete fastening system has been developed for both versions.

Circle No. 228 on Subscriber Service Card

## Digital Instrument Package

A standard digital instrument package for logging applications, consisting of a V-70 digital voltmeter, a scanner and an 11-channel printer is available from Cubic Corp. The high-speed manual ranging data system will plug into any conventional a-c outlet and readout data at 100 channels per minute. System accuracy has been set at 0.01% plus or minus one digit. Called the S-70



the package has been designed for applications in environmental test data recording, modular check-out and production check-out, where recorded data is necessary. The portable instrumentation package can also be assigned to rugged field-test projects where logging of digital information is required.

Circle No. 229 on Subscriber Service Card

## High-Speed Camera

A 16 mm camera with better resolution, greater capacity, fast film acceleration to regulated velocity and performance reliability is available from Wollensak Optical Co. The unit has 1200-ft. capacity, darkroom loaded "T" core magazine, and a variable speed





range controlled by a solid-state loop servo device.

The camera has timing markers, electrical inter-locks, ready lights, speed indicators, footage counter and standard 115V a-c, 60 cycle power input. The unit is also supplied in an RFI-protected oscillographic version for high-speed oscillographic recording.

Circle No. 230 on Subscriber Service Card

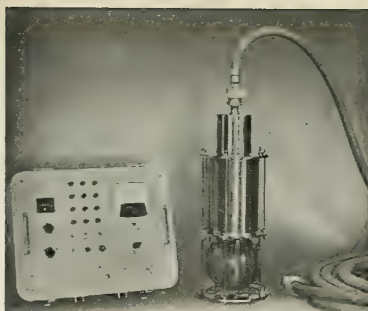
## Teletype Rekeyer

Ortronix Inc. has developed a fully transistorized teletype rekeyer offering increased reliability and performance over the vacuum tube equivalent. In addition to reducing size by 90%, the transistorized unit is less expensive and requires less maintenance time but supplies higher power output. The Model #5128 transistorized rekeyer is designed to condition signals necessary to drive #14 or #28 teletypewriters. Outputs of 30ma and 60ma are available for operation to hold or energize the teletypewriters.

Circle No. 231 on Subscriber Service Card

## Scintillation Detector

A transistorized, portable, and battery-operated underwater scintillation detector has been designed and produced by Franklin Systems Inc. The instru-



ment measures all beta and gamma radiation in the sea to depths of 1000 feet. Model 60-4 scintillation detector consists of a submersible detector probe, cable, and readout package. The probe contains a 7-in.-diameter plastic scintillation sphere with a nominal 20 mg/cm<sup>2</sup> waterproof coating which detects the undersea radiation.

Circle No. 232 on Subscriber Service Card

## Microminiature Relays

A series of sensitive, 6PDT, microminiature relays for dry circuit to high-level switching is available from Electronics Division of the Iron Fireman Manufacturing Co. Designated the 100N Series, these new relays conform to and exceed the test specifications of MIL-R-5757D, and feature bifurcated

contact construction for longer life and greater reliability.

Circle No. 233 on Subscriber Service Card

## Grooving Tool

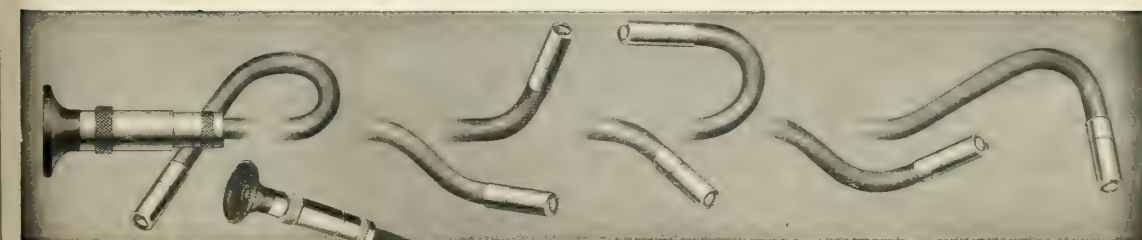
A tool designed specifically to cut accurate grooves for O rings, or similar seals, on the curved surface of a cylinder is available for Avco's Research and Advanced Development Division. The ring groove cutter is a lightweight fixture attachment for a machine tool with a rotating table, such as a lathe. A work piece is placed in the fixture and a cutting tool is set into it to produce the O ring groove.

Circle No. 234 on Subscriber Service Card

## IF/Parametric Amplifiers

Airborne Instruments Laboratory Division of Cutler-Hammer, Inc., is marketing a complete line of IF preamplifiers. Standard models are at 30 mc and 60 mc with both narrow-band and wide-band versions available. The low-noise preamplifiers include single-ended, double-ended balanced and unbalanced input configurations.

A low-noise parametric amplifier covering the 2200 to 2300 mc telemetry band is also available. The amplifier is of the one-port variety, with both input and output at the signal frequency. One



*Focusing eyepiece for convenience of user.*

**For the ultimate  
in precision viewing of  
intricate, hard-to-reach areas . . .**

**A.C.M.I. Fiber Optic  
*Flexible*  
Borescopes**

**FOR** visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

*Please send details and sketch  
of your requirements.*

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# Questions and Answers about the

## GLOBAL COMMUNICATIONS CAPABILITIES of RCA

**What capabilities? From which subsidiary of RCA?**

From RCA Communications, Inc.

Uncommon capabilities for designing and operating **ground communications networks of world-wide scope** needed by contractors, sub-contractors, and government agencies engaged in **space or missile projects**.

RCA Communications also provides facilities for private communications... data communications... and commercial communications of all kinds — telegraph, telex, radiophoto, and radiotelephone by means of radio and coaxial cable channels. It designs not only completely new systems but also systems incorporating the most efficient and economical arrangement of established facilities.

**How were these capabilities acquired?**

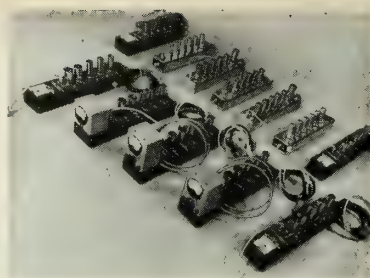
Through 41 years experience in building and operating a world-wide communications system. Today, RCA's integrated telegraph, telex, and radiophoto networks reach more than 100 countries and ships at sea.

**In what ways does RCA make its capabilities available?**

As contractor or consultant. For more information, write RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4. Tel. Hanover 2-1811, Area Code 212.



The Most Trusted Name in Communications

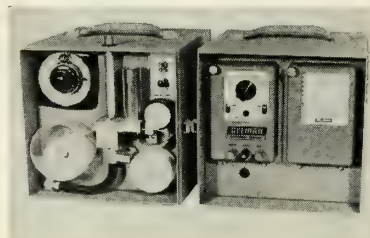


of the major features of this new parametric amplifier is that tuning is not required and a maximum system noise figure of 2.5 db is guaranteed for an 8 db second-stage noise figure.

Circle No. 235 on Subscriber Service Card

### Phototape Sampler

A Phototape Sampler which eliminates the manual collection and evaluation of samples of dust from the air is available from Gelman Instrument Co. It is also ideally suited for many gas sampling and determination applications. The sampler automatically collects samples on a paper tape and then

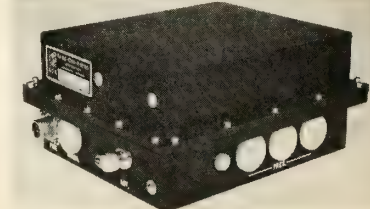


evaluates and permanently records the concentration of dust or gas on a strip chart. Operation is automatic and fool-proof. The strip chart is driven by a synchronous motor which accurately relates the time of day at which the sample was taken. In this way the accumulation of errors resulting from the repeated addition of slight inaccuracies in sampling time duration is completely eliminated.

Circle No. 236 on Subscriber Service Card

### S-Band Transponder

Aero Geo Astro Corp. has developed an S-Band (2700 to 2950 mc) radar transponder, the AGA S/T-CV. Major feature of the transponder are



its crystal video receiver and the fact that it is completely transistorized except for the ceramic triode transmitter tube. These features make the transponder much smaller and lighter than conventional transponders with superheterodyne receivers. The AGA S/T-CV has a receiver sensitivity of -40 dbm over the frequency range and a transmitter output of 3 watts minimum. Higher-power models are available. Input voltage is 28 VDC and power drain is 0.25 amps at a 1000 pps rate.

Circle No. 237 on Subscriber Service Card

### Power Supply

A new model of the Amplitude-Regulating Power Supply, Type 1236-B, which provides 1-kc square-wave modulation from an internal generator, is being made by the General Radio Co. Designed for operation with uhf and vhf oscillators, this improved instrument maintains the oscillator output amplitude constant as the frequency is varied. The square-wave modulation feature increases the usefulness of the power supply, since it permits the use of a tuned audio amplifier following the detector, thus achieving high sensitivity with a simplified setup.

Circle No. 238 on Subscriber Service Card

### Communications Receiver

An 11-tube Superheterodyne Receiver, Model 850/2, from Marconi Instruments, 600 Kc, completing the range of Eddystone Receivers which now give coverage from 10 Kc to 1000 Mc. 5uV Sensitivity for 15 db to Noise Ratio, variable bandwidth from 400 cps to 6 Kc and greater than 50 dB image rejection are featured in this design.

Provisions are included for CW AM and SSB reception. This instrument is also valuable for use as an RF Bridge null indicator, RFI detector and for general low-level laboratory measurements.

Circle No. 239 on Subscriber Service Card

### Damped Accelerometers

Kearfott Division, General Precision Inc., is producing the F2401-01A accelerometer, a d-c torque-restrained device possessing a useful dynamic measuring range of greater than twenty million. The sensitive element consists of a symmetrically located differential transformer pick-off and a pair of force coils mounted in common on the instrument measuring axis. The high degree of symmetry of both force coils and pick-off coils minimizes the errors which might otherwise occur during vibrator inputs.

Circle No. 240 on Subscriber Service Card



# contracts

## AIR FORCE

\$3,880,000—Aerojet-General Corp., Sacramento, Calif. for production of Stage II *Minuteman* solid propellant rocket motors.

\$123,330—Aveco Corp., Wilmington, Del. for development, fabrication and test of decoys for the *Nike-Zeus* target support program.

\$688,000—American Bosch Arma Corp., Garden City, N.Y. for production of classified missile guidance sets.

\$600,000—United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn. for research and development on an advanced stellar guidance system.

\$200,000—Douglas Aircraft Co., Santa Monica, Calif. for production of ground equipment for *Skybolt* missiles.

\$1,000,000—North American Aviation, Rocketdyne Div. for follow-on procurement of propulsion systems for *Atlas* missiles.

\$65,000—Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corp., Los Altos, Calif. for klystrons and magnetrons.

\$300,000—Solid State Radiations, Inc., Los Angeles, Calif. for research and development in nuclear detection.

\$106,583—Delco-Remy Division, General Motors, for upgrading performance of silver-zinc batteries used in *Minuteman* ICBM.

\$104,000—W. R. Grace & Co., New York, N.Y. for the development of manufacturing method for a new type of thermistor.

## ARMY

\$1,790,959—Sperry Utah Co. Division, Sperry Rand Corp., Salt Lake City, Utah for tactical missile repair parts (3 contracts).

\$354,103—Ralph M. Parsons Co., Los Angeles, Calif. for development of criteria and definite drawings for *Nike-Zeus* system and revisions to test facilities and standard plans for *Nike-Zeus*.

\$71,937—Raytheon Co., Lexington, Mass. for concurrent repair parts, *Hawk* missile systems.

\$288,409—The Martin Co., Orlando, Fla. for *Lacrosse* contractor technical services.

\$245,000—M. W. Hills Construction Inc., Salina, Kansas for furnishing and installing silo sleeves for blast closures in operational base, missile launch complexes, at Lincoln AFB, Altus AFB and Walker AFB.

\$9,481—Douglas Aircraft Co., Inc., Santa Monica, Calif. for procurement of *Nike* replenishment spare parts—fail-safe kit.

\$73,300—Nortronics, a Div. of Northrop Corp., Anaheim, Calif. for *Hawk* launchers.

\$4,882—Western Electric Co., Inc., New York, N.Y. for procurement of replenishment repair parts, *Nike* missile system.

## MISCELLANEOUS

\$400,000—Aveco Corporation, Lycoming Division, Stratford, Conn. from Thiokol Chemical Corp. for production of an undisclosed number of rocket motor cases for the *Dyna-Soar* manned space glider program.

\$20,000—Shielding, Inc., Riverton, N.J. from General Electric Co. for a manufacturing, controlled environment facility to be installed in G.E.'s Space Technology Center, Valley Forge, Pa.

\$20,000—Lamtex Industries, Inc., Farmingdale, N.Y. from Thiokol Chemical Corp. for the development and manufacture of fiberglass-reinforced plastic cases for *Minuteman* ICBM solid propellant rocket engines.

\$80,000—American Electric, Inc., Paramount, Calif. from The Boeing Co. for silo closure equipment for the *Minuteman* program.

\$250,000—Space Recovery Systems Div., Itek Corp., El Segundo, Calif. from Douglas Aircraft Co. to develop recoverable data capsules for use in suborbital tests of NASA's *Echo A-12* satellite.

\$250,000—Dorsey Trailers, Inc., Elba, Ala., subsidiary of Dorsey Corp., from The Boeing Co. for van bodies to be installed on truck chassis for use at *Minuteman* launching sites.

\$248,777—Yardney Electric Corp. from The Martin Co. of Denver, Colo. for silver-zinc batteries to be used in the *Martin Titan II* missile.

\$200,000—Microlab, Inc. from The Boeing Co. for electronic assemblies for *Minuteman* hardened and dispersed silo complexes.

\$150,000—Paul Hardeman, Inc., Stanton, Calif. from The Boeing Co. for installation of electronic ground support equipment for the AF *Minuteman*.

General Electric Co. from The Boeing Co. for electric power unit to be used in launch control facilities in *Minuteman* program (amount not disclosed).

Dynamics Corporation of America from the Hughes Aircraft Co. for construction of a FM receiving system that will pick up signals reflected off a passive satellite (no amount disclosed).

Bissett-Berman Corp., from Raytheon, Santa Monica, Calif. for work on *ARPAT* ballistic missile defense.

## NASA

\$97,350—The Eagle-Picher Co., Chemical and Metals Div., Cincinnati, Ohio for four items of batteries zinc silver oxide.

Electronic Memories, Inc., Los Angeles, Calif. for the preliminary design of a magnetic core memory for use in space probe vehicles (no amount disclosed).

## NAVY

\$1,500,000—Sperry Gyroscope Co., Syosset, L.I., N.Y. for support and training equipment and services in connection with navigation subsystems for ballistic missile submarines.

\$780,000—B. F. Goodrich Aerospace and Defense Products, Akron, Ohio, for the manufacture of solid fuel motors for the *Sidewinder* missile.

\$493,742—Ruscon Construction Co., Charleston, S.C. for construction of missile assembly control bldg. at the Naval Weapons Annex, U.S. Naval Ammunition Depot, Charleston, S.C.

\$487,465—Servomechanisms, Inc., El Segundo, Calif. for true air speed computer components.

\$266,000—B. F. Goodrich's rocket motor operation, for the production of solid fuel motors for *Loki* atmospheric sounding rocket.

\$259,976—Fred A. Arnold, Inc., Los Angeles, Calif. for modifications to missile assembly and range users engineering bldgs., Naval Missile Facility, Point Arguello, Lompoc, Calif.

\$218,673—Technical Appliance Corp., Sherburne, N.Y. for development of ten phase rate antennas for installation at U.S. Navy Space Surveillance Station.

\$131,800—The Cardan Co., Los Angeles, Calif. for construction of vehicle support bldg., launch complex I, Naval Missile Facility, Point Arguello, Lompoc, Calif.

\$85,566—Quantatron, Inc., Santa Monica, Calif. for research and development on a coherent infrared ranging system for missile borne applications.

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## names in the news



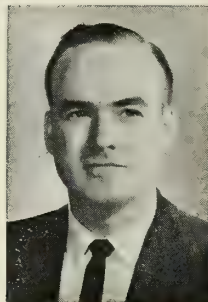
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**Leon L. Farnham:** Appointed corporate director of advanced engineering of Fairchild Stratos Corp., Hagerstown, Md. He will direct research and development studies into advanced areas of aerospace technology and will initiate and evaluate new concepts leading to future aerospace applications in his newly created corporate post.

Farnham has been associated with General Electric's Missile and Space Vehicle Department where, most recently, he had been manager of design engineering on the *Apollo* spacecraft program; he previously managed the engineering design and integration of all flight vehicles. Prior to his position with General Electric, he was a specialist in design of high-speed aircraft and missile structures, at Chance Vought, and had earlier been with the Martin Co.

**Lloyd A. Hart:** Named to the new post of vice president and manager of Contract Sales, new department of Forbes and Wagner, Inc., Silver Creek, N.Y. The position entails responsibility for securing military and commercial contracts and subcontracts for custom electronic, electrical, electro-mechanical and mechanical assemblies, and for promoting the company's lines of electronic magnetic components. Hart has held managerial positions with General Electric Co. and General Dynamics Electronics.

**William M. Jenkins:** Appointed manager of the newly created European Operations for the Information and Control Systems Product Section, General Electric Company's Defense Systems Department. The operation will be headquartered at Wiesbaden, Germany, and staffed by approximately 500 employees who will install, checkout, maintain and support the Air Weapons Control System 412L. Jenkins has been with General Electric since 1949.

**L. D. Rexroat:** Elected president and chairman of the board of U.S. Science Corporation. He joined the organization in 1960 as vice president of marketing and member of the board of directors. Rexroat, who has had 20 years of management experience in industry and the Air Force, has previously been associated

with Sylvania Electric Products, Inc., Haller Raymond and Brown Inc., and the Philco Corp.

**John L. Sigrist:** Promoted to director of programs in Douglas Aircraft Company's Missile and Space Systems Division. Sigrist, who joined the company in 1939, will be responsible for program management of the *Nike-Zeus*, *Saturn S-IV*, *Thor* and *Genie* programs, as well as all new programs assigned to the Missile and Space Systems Division.

**William T. Golden:** Elected chairman of the board of trustees of System Development Corp., Santa Monica, Calif. Golden, a board member since 1957, succeeds **Fran Collbohm**. He is a director of many national corporations and a well-known industrial and financial management expert. He has served on many government financial and procurement projects and, as a special consultant to the White House, reviewed the organization of military-scientific activities incident to the Korean War. Golden also served with the Hoover Commission and was special assistant to the commissioner of the Atomic Energy Commission from 1946 to 1950 and acted as consultant to that agency until 1958.

**Raymond W. Meyer:** Named director of quality assurance for Eitel-McCullough, Inc. In this newly created position, he will develop corporate quality assurance policies and coordinate the quality control programs of the company's five operating divisions. Prior to joining the firm, he was associated with Lockheed Electronics, the Burroughs Corporation, Hoffman Radio Corporation and Radio Corporation of America.

**Earl L. Schoenlein:** Named vice president of sales of Thompson Industries division of Space Equipment Corp., Los Angeles. Prior to joining the company, he had been associated with Houston-Fearless Corp., and North American Aviation, Inc.

**John M. Lambert:** Appointed manager of Advanced Systems in the Systems Division

of Avien, Inc. In his new post he will be responsible for development of advanced radar and communications systems. Lambert was previously project engineer with the Defense Systems Department of General Electric Co.

**E. D. Jernigan:** Appointed to the new position of manager of aerospace program at Industrial Nucleonics Corp., Columbus, Ohio. In this assignment, he will be responsible for the direction of all industrial nucleonics research and development activities pertaining to the U.S. Air Force and NASA. Prior to joining the company, Jernigan was with Motorola, Inc.

**Robert D. Schmidt:** Appointed vice president-marketing, Electronic Memories Inc. Before joining the company, he was manager of the Components Division of Ampex Computer Products Company, and has held a variety of executive positions with Telemeter Magnetics, Inc., Remington Rand and the U.S. Navy.

**Dr. Murray I. Disman:** Named manager of microwave tube development at Eitel-McCullough, Inc. He will direct the development of Eimac reflex klystrons, traveling-wave tubes, voltage-tunable magnetrons and low-power amplifier klystrons. Before joining the company in 1959 Disman was a research associate on high-power traveling-wave tubes at Stanford Electronics Laboratory, Stanford University, Calif.

**Virginia Allen:** Appointed controller at E. V. Roberts & Associates, Inc., Los Angeles. Miss Allen, with the firm for over seven years, will supervise financial operations of the corporation. She was formerly associated with Liberty Manufacturing and Arc Advertising, both in California.

**Gerald S. Linseth:** Appointed Sales Engineer of Clevite Transistor, Division of Clevite Corp., Los Angeles office. Linseth was formerly with Hughes Semiconductor Division.

**William J. O'Sullivan, Jr.:** Scientist at the NASA Langley Research Center, Va., has received a \$5000 award from the agency. The award was given for his

missiles and rockets, December 4, 1960



contribution to space science and technology in conceiving an inflatable space vehicle invention and initiating and directing its successful development. O'Sullivan has been a research scientist at the Langley Center since 1938 and at present is head of the Space Vehicle Group.

**Dr. James A. Bittles:** Joined Electro-Optical Systems, Inc., as a senior scientist in the Quantum Physics department. His duties will entail a broad research program in materials for masers, lasers, and

related areas. Before joining the company, Bittles was a research associate at the University of Southern California; still earlier, he was a research chemist at E. I. duPont de Nemours, Wilmington, Del.

**Dr. Peter M. Kelly:** Named head of the instrumentation and electronics department at Astropower, Inc., Costa Mesa, Calif. The recently established office is conducting research and development activities in such areas as information processing, advanced instrumentation and spacecraft electronics. Previously, Kelly had been with the Aeronutronic division of Ford Motor Co. and Hughes Aircraft Co.

**Joseph A. Ricca:** Joined Ford Motor Company's Aeronutronic Division, Newport Beach, Calif., as manager of planning for electronics operations; **Charles H. Sword** has joined as manager of operations staff for electronics operations. Ricca, a former management consultant, has had a number of years experience in the electronic field with Hubbard and Co., DuMont, Norden-Ketay Corp., and General Electric. Sword will be responsible for administrative, contract-administration, and market-planning activities. He has been associated with North American Aviation, Computers and Data Systems, and with Autonetics.

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**National Aerospace Support and Operations Meeting**, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Fla., Dec. 4-6.

**19th Annual Electric Furnace Conference**, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.

**Eastern Joint Computer Conference**, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C., Dec. 12-14.

**Annual Meeting, American Association for Advancement of Science**, Denver, Dec. 26-31.

**Annual Meeting, American Statistical Association**, Roosevelt Hotel, New York City, Dec. 27-30.

## JANUARY

**8th National Symposium on Reliability and Quality Control**, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

**National Plant Engineering and Maintenance Show and Conference**, Convention Hall, Philadelphia, Jan. 22-25.

**Solid Propellant Rocket Conference**, ARS, Baylor University, Waco, Tex., Jan. 24-25.

## FEBRUARY

**Western Electronic Week and Pacific Electronic Trade Show**, Las Vegas and Los Angeles, Feb. 3-11.

**Winter Convention on Military Electronics**, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

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# Inside Story of Apollo

**T**HE U. S. ENTRY in the race for the moon is off to an excellent start with the selection of North American Aviation as prime contractor on the *Apollo* spacecraft.

The California firm has won the toughest and most important competition since the birth of the young missile/space industry. From a company standpoint, the losers must grieve and we grieve with them. But certainly they will agree that the award has gone to an able competitor. The national interest has been well served.

How did North American win? That soul-searching question now is being asked in Philadelphia, Baltimore, St. Louis and elsewhere. We give you here the inside story of just how North American walked off with the award.

First, let us deal with the most obvious answer—politics. On this page, we reported last spring a very real fear of almost every missile/space firm in California: that the new Administration might take political vengeance on the home state of former Vice President Richard M. Nixon. North American was one of the firms most concerned, for apparent reasons. This was not a worry taken lightly. Top executives of California firms, both Democrats and Republicans, met privately to discuss the problem.

The award to North American has laid that ghost to rest. The Administration has demonstrated in the most effective way possible that it places national welfare ahead of its political welfare.

If not politics, what then? Was the contract let to a firm hungry for business? North American stands in the No. 1 position on the list of NASA contractors for Fiscal '61, its \$75 million total one and a half times that of the next company on the list. It is in third position on the list of Department of Defense contractors, with over \$964 million in military contracts. Company officials feared this very success might work against NAA in the *Apollo* competition. Again, in placing the contract in defiance of the conventional spread-the-business pattern, the Administration exhibited a welcome recognition of the importance of this project.

With both politics and affluence working against it, North American's secret of success in the *Apollo* competition lies elsewhere. It can be traced back to 1946, when NAA entered the guided missile field with a research and study contract. Out of this early work came the Air Force's SM-64 *Navaho*, a long-range air-breathing strategic missile. A major effort, the *Navaho* program was cancelled when the feasibility of an intercontinental ballistic missile became apparent.

Capable management even then was laying the foundation responsible for today's *Apollo* success. NAA President Lee Atwood and Board Chairman J. H. "Dutch" Kindelberger, among the first to sense what was ahead for the aircraft industry, diversified North American into missiles, nucleonics, electronics and rocket propulsion, building a strong technical competence in each of the new fields.

**B**UT THE SIGNIFICANT date in the inside story of the *Apollo* victory is 1941—20 years ago. That was the year a young aeronautical engineer with degrees from Northwestern and Cal Tech joined North American in the aerodynamics group. His name was Harrison A. Storms, Jr. He became group leader in 1947 and was named assistant chief technical engineer in 1951. By 1953, he was chief technical engineer. Three years later he was promoted to manager, research and development, and the following year he became chief engineer of the Los Angeles Division. In February, 1960, Storms was named a vice president of the Los Angeles Division. His accomplishments included work on the B-25, P-51, T-6, T-28, B-45, F-86, F-100, F-107, F-108, T-39, B-70 and the space probing X-15.

Then in December, 1960—another significant date in the *Apollo* story—North American took a major gamble. Company management looked at the prospects of the B-70 and the prospects of the space program. Storms moved out of the Los Angeles Division to become president of the Missile Division at Downey, Calif., now the Space and Information Systems Division.

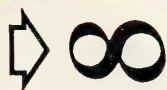
With him, Storms took a major portion of the X-15 design team, including pilot Scott Crossfield. At Downey, they put together their *Apollo* proposal and went after the contract. Last week, they got it.

Several weeks ago, we spent an evening with Harrison Storms in New York. Over dinner and later over the wailing of a blues singer in a Village jazz joint, he talked *Apollo*, *Apollo*, *Apollo*. Stormy desperately wanted that contract, not just for North American, but because he felt his X-15 team could do the best job on it for the nation. He's that kind of man. We're glad he won.

So the inside story of North American's *Apollo* success is an old one—capable men on the technical team and capable men in management. It's a hard combination to beat—particularly when sparked by a burning desire to build the best and backed by a long record of doing exactly that.

William J. Coughlin





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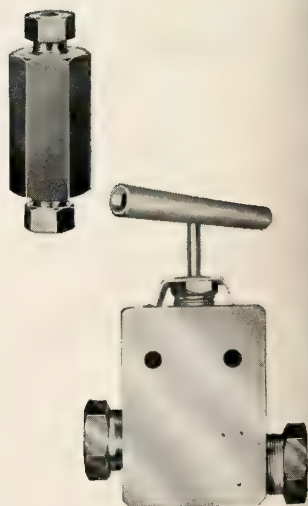
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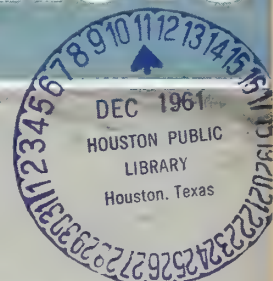
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# missiles and rockets

THE MISSILE / SPACE WEEKLY



First Photo—Planting Combat Minuteman in Montana

Wilson: Atmospheric Tests 'Critical' . . .

Nuclear Rocket To Cost \$1 Billion Plus . .

OF<sub>2</sub> Shows Promise as Space-Storeable . . 22

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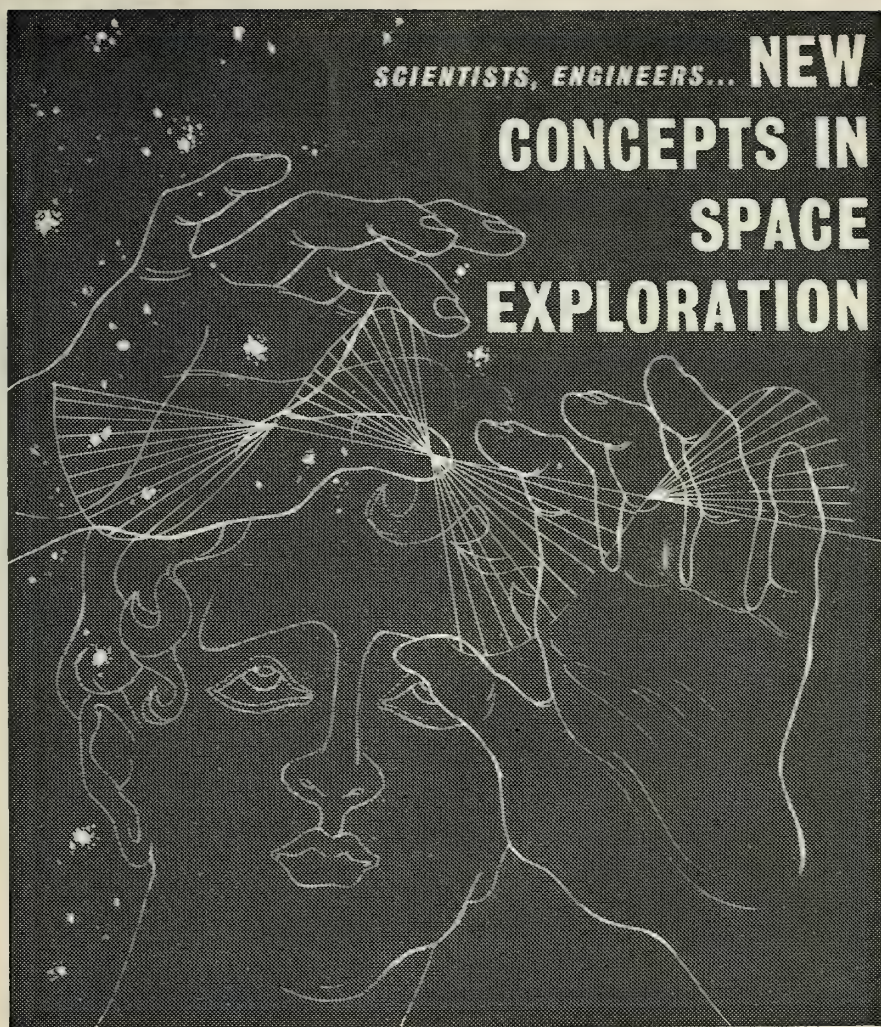
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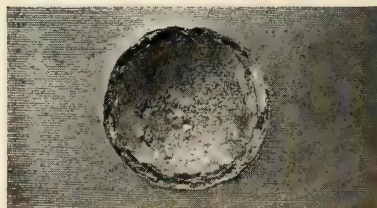


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## THE COVER

*Helicopter view of one of 150 Minuteman silos going in at Malmstrom AFB. Photo, first to show progress in readying the base for SAC by mid-'62, was taken Oct. 31. (Bell Helicopter photo)*



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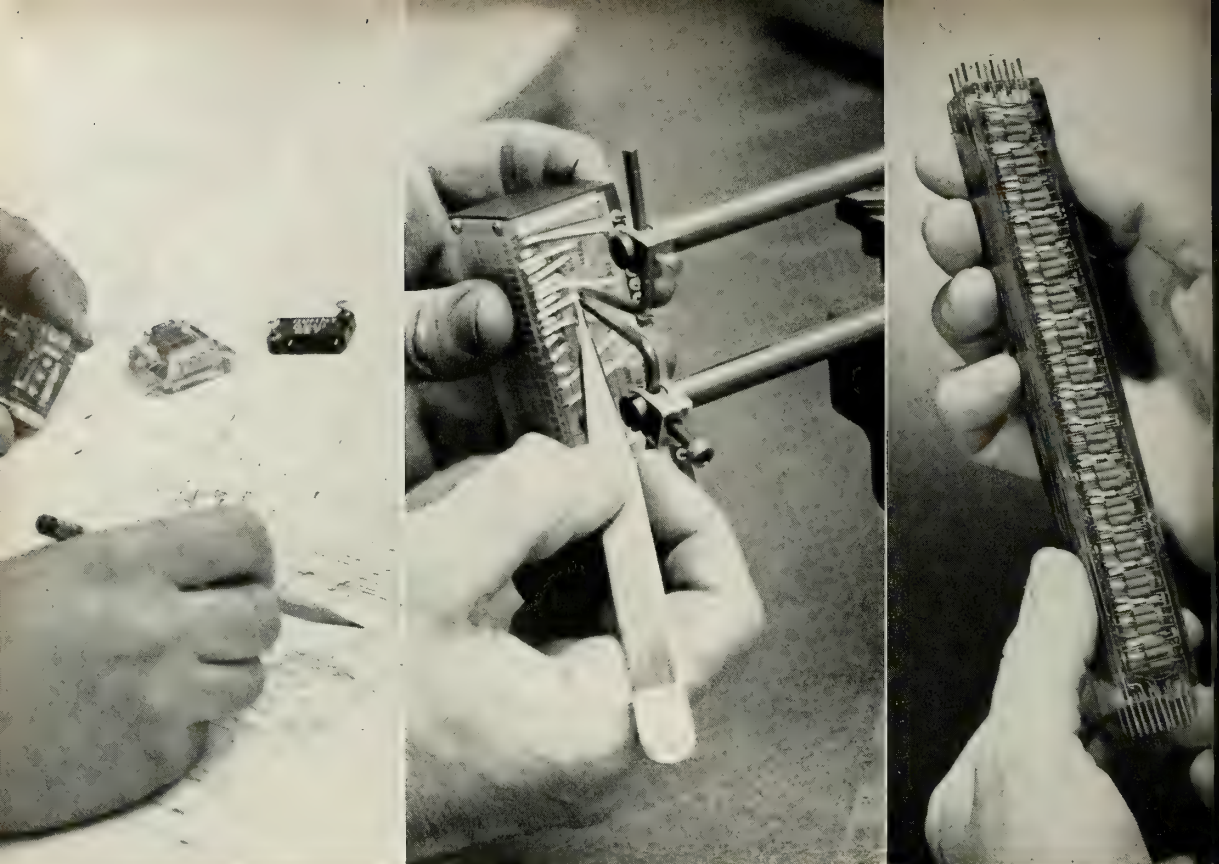
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\*U.S. Reg.

†U.S. Reg. Pdg.

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Package design of Weld-Pak® module

Welding interconnections on Weld-Pak® module

Raytheon Weld-Pak® logic stick

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## letters

### NSF & Apollo—Clarification

*To the Editor:*

Your issue of Oct. 30 contains an item on p. 10 reporting that the National Science Foundation is now undertaking a study to determine the relative costs of the *Apollo* program. There has obviously been a misunderstanding concerning this alleged study, and I should like to clear it up for the benefit of your readers.

The Foundation is not making such a study. The original statement that gave rise to this report was part of a response to an inquiry as to whether the Foundation believed the effort to send a man to the moon was taking too much of the nation's resources and manpower, when balanced against the needs of science in other areas, such as oceanography or cancer research.

It was stated at that time that the full effects of this program are not yet known, and that the National Science Foundation, the National Aeronautics and Space Administration, and other agencies with science responsibilities would cooperate in keeping a close watch on the relative dollar and manpower costs of all these programs, balanced against their relative importance to the national interest. The MISSILES AND ROCKETS statement that, within NSF, the Office of Science Resources Planning would be responsible is of course correct.

Because the original statement was made on a radio broadcast rather than in written form, it was not available for exact checking, and your source could easily have been misled. The M/R item was a faithful and accurate report of information that was, unfortunately, erroneous in its particular reference to Project *Apollo*.

I trust that this will help to clear up questions that may have arisen concerning the item.

Alan T. Waterman  
Director  
National Science Foundation  
Washington

### Ion Test Controversy?

*To the Editor:*

I was greatly dismayed over the misleading implications contained in your article entitled "EOS Urges 'More Realistic' Test" (M/R, Nov. 20, p. 27), in reference to proposed ion engine testing programs.

The technical material in your article emanated from a paper I presented before the ARS Space Flight Report to the Nation. This document in no sense contained anything condemning the NASA program, nor could it properly be considered controversial. When I talked to your reporter, I pointed out that there were several different approaches to ion engine testing. NASA has adopted one method; we have proposed another. This is an honest difference of technical opinion which makes for technological progress, not "controversy." At best your choice of words was unfortunate.

I should also like to point out that your use of the phrase, "more realistic," is totally out of context. The implication of your headline is that we have judged the NASA program unrealistic. Actually, the only thing I indicated as being unrealistic was the use of spin stabilization for the test capsule, which subjects the engine to an *unrealistic operating condition* (i.e., the engine will not be used on a spinning vehicle in any real application). This particular aspect of their test plan represents only a minor portion of the whole test concept. The other reason I gave for preferring an attitude-stabilized capsule was that it permits instantaneous rather than integrated measurements, but this does not imply that the NASA test is unrealistic on this account. Thus the quest for "more realistic" testing in no way reflects on the overall program or its objectives, but merely to one particular aspect.

In another part of your story you say, in reference to NASA's testing technique: "EOS is presently taking issue with this procedure, even though its engine isn't involved." Neither I nor EOS takes issue with NASA's procedure. We are merely discussing another method of testing which is unrelated to NASA's approach, or to anybody else's for that matter.

I strongly believe in the vital role played by trade publications in informing industry of important technical developments. However, in the present instance, your story appears to have as its purpose the creation of a political issue where none, in fact, exists; rather than the straightforward reporting of the technical aspects of ion engine testing.

I cannot help but feel that you have led many to believe that a raging controversy now exists between EOS and NASA and that I or my company feel the need to decry publicly the method which NASA has chosen. Such a contention is patently ridiculous and I am writing this letter to make this clear.

Both testing techniques are interesting and both have technical merit—only actual space test will place them in their proper perspective.

Ronald S. H. Toms  
Senior Scientist  
Electro-Optical Systems, Inc.  
Pasadena, Calif.

### Day's Work for Day's Pay

*To the Editor:*

Everyone gets on the gravy train when a government contract is let. I have worked in Civil Service for twenty years, in installations, programming, letting contracts, etc., and I have noticed poor organization particularly in the missile business. It is easy money for the labor unions and, knowing the urgency of the program, they can lag as much as they want. . . .

Civilian contractors should take a good long look at their payrolls, the quality of their personnel, and maybe some savings can be passed on to the government.

A Civil Servant  
Cheyenne, Wyo.



## THERMOPLASTIC RECORDER/DISPLAY SYSTEM

**Ground-level detail  
projected to vehicle  
for immediate use**

At 40,000 feet and higher a pilot could spot ground-level targets no larger than a tank by using a new recorder/display system developed by General Electric's Light Military Electronics Department. A photographic view is obtained from side-looking radar, recorded on thermoplastic tape, and displayed instantly on a screen in the cockpit. Requiring no cathode ray tube, the screen has variable brightness that permits operation in ambient light, without the use of a hood.

At extreme heights—or in space—the system is capable of providing great detail and a permanent data record of TV, infrared, or any other “eyes” of the vehicle. Combined or composite displays are also possible for integrated display applications. The thermoplastic recorder/display system is a typical example of LMED contributions to progress in aero/space electronics.

150-07

**GENERAL  ELECTRIC**

**Light Military Electronics Department**

Utica, New York



# The Countdown

## WASHINGTON

### DOD Spending: The Upward Curve

As the FY '63 defense budget nears its final form before being submitted to Congress, the new spending level is being estimated at about \$50 billion in the Pentagon. The new authorization request is expected to top \$51 billion—possibly approach \$52 billion. The current long-range spending estimate over the next five years: An average of about \$50 billion a year. Spending for FY '62 is expected to nearly top \$47 billion when the totals are in.

### NASA Spending: The Steep Ascent

Estimates of the NASA authorization request for FY '63 have taken another jump upward. The new figure is about \$4 billion to \$4.2 billion, compared to the old (about one month) estimate of \$3.7 billion. The reason for the increase: A decision by the Kennedy Administration to push R&D on orbital rendezvous techniques and the giant *Nova* booster as part of the *Apollo* Manned Lunar Landing Program.

### Limiting the Skybolt Buy

The Kennedy Administration's decision not to extend the procurement of B-52 intercontinental jet bombers will have an important but so far little-mentioned side effect. In all, the total Air Force buy of B-52's includes only some 100 B-52 H's and only the H models will carry the Douglas *Skybolt* ALBM. This means that *Skybolt* procurement by the U.S. Air Force will now be limited at most to about 400 missiles plus some spares for reloading and training.

### Gamesmen on Capitol Hill

The Senate Space Committee and the Senate Commerce Committee appear to be heading for a sharp jurisdictional fight over the planned commercial communications satellite. The Space Committee indicates that it will hold hearings on legislation involving communications satellites. However, in the past, all legislation involving communications has been considered the special hunting preserve of the Commerce Committee.

### Mobile Minuteman Moving

Resumption of greater R&D work on the all-but stalled mobile *Minuteman* program is still part of future DOD plans. New money for the program is now considered to be securely included in the FY '63 Air Force budget. And Boeing is receiving additional funding—\$3.08 million—for R&D on both the fixed and mobile *Minuteman* systems.

### Alkali Flats vs. Rogers Dry Lake

Fight is shaping up between White Sands Missile Range and Edwards AFB for the job of recovering spacecraft. Arguments are being advanced that WSMR's Alkali Flats offer better landing conditions than Edwards' Rogers Dry Lake, which handles the *X-15* and is bidding for *Apollo* and *Dyna-Soar* recovery role (M/R, Nov. 27, p. 144). WSMR backers want to turn Alkali Flats into a "national aerospace landing site."

missiles and rockets, December 11, 1961

## INDUSTRY

### Saturn S-1B Stage Award Due

Awarding of a prime contract to build NASA's *Saturn S-1B* booster is now expected about Dec. 15. The stage will have four F-1 engines developing a total of 6 million lbs. thrust.

### Front Office Intelligence

Look for Laboratory for Electronics of Boston to be admitted to New York Stock Exchange trading shortly after Jan. 1. . . . CBS Laboratories, Stamford, Conn., is planning to double its present factory space to handle an expansion in dry-film lubricants and possibly an increase in its Photoscan aerial recon system. . . . Martin Marietta has re-established its (*Titan*) Missile Site Activation Division, headed by Vernon L. Rawlings, at Denver. . . . L. Eugene Root, president of Lockheed Missile and Space Co., is the 1962 president of the Institute of the Aerospace Sciences . . . and NASA has hired F. W. Godsey Jr. as a consultant in its ComSat program. He is a former president of Electronic Communications Inc. and vice president of Westinghouse Electric Co.

### Norair Hunting MRBM Role

COUNTDOWN hears Northrop's Norair Division has 122 people working on the as-yet-unfunded Air Force mobile *MRBM*. The division is seeking an integration, assembly and test role and is understood to have already conducted a survey in Europe of roadways, bridges, tunnels and vehicle types. . . . The Martin *Pershing*, incidentally, is beginning field trials (no firings) early next year in Alaska, Arizona, and a tropical area still to be selected.

### TOW Evaluation Under Way

The Army is evaluating bids on TOW (tube-launched, optically-tracked, wire-guided) antitank missile, which is intended as a successor to France's *Entac*. Twenty-five firms were asked for bids; a decision on awarding contracts is due by Jan. 1.

## INTERNATIONAL

### Russia Beefs Up Defense Spending

A 46% increase is planned in the Soviet defense budget—from an announced \$10.2 billion in 1961 to \$14.7 billion in 1962. The new figure—not including military funds hidden elsewhere in the budget—is Russia's highest peacetime outlay for defense.

### Overseas Pipeline

France's government rocket propellant and explosive manufacturing agency, Le Service des Poudres, now employs some 6000-7000 persons in four main labs and 12 production facilities. . . . Britain's Royal Navy and the Royal Australian Air Force are now testing missiles against the Short Bros. & Harland Ltd. Canberra U-Mark X target drone, which has a ceiling up to 54,000 ft.

# The Missile/Space Week

## Space Council Building Technical Staff of 25

The staff of the National Aeronautics and Space Council is being sharply increased to handle its chore as the White House's chief space advisor.

The Council—composed of various cabinet officers—will have a staff of 25 by the end of the current fiscal year, according to Dr. Edward C. Welsh, the panel's secretary.

Some 12 are already on board—the latest addition being Max W. Hunter, formerly chief engineer-space systems of the Missile and Space Systems Division of Douglas Aircraft Co.

Hunter will serve as an Aerospace Assistant to Dr. Welsh. Two others—Dr. Charles Sheldon, formerly on the staff of the House Space Committee; and Henry G. Edler, formerly President of the National Rocket Corp.—have already been appointed.

When Dr. Welsh assumed his position last March, the Council had no staff and no funds.

Congress finally approved a Fiscal 1962 appropriation of \$545,000. Dr. Welsh indicated that the budget request for next year would be just about the same, although the staff is expected to grow to 30.

## Procurement Changes

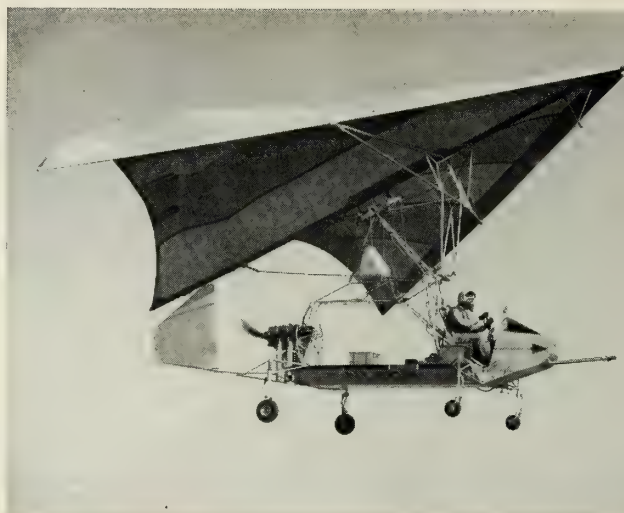
A draft of changes in Armed Services Procurement Regulations (Part 4, Section III) proposed by the Defense Department now is being circulated to industry associations for comments. These are due by Jan. 2.

The proposed new DOD policy calls for a priority category placing firm fixed price and cost-plus-incentive-fee contracts at the top of the list of preference, and cost-plus-fixed-fee and retroactive price redetermination awards at the bottom of the scale. It represents five months of effort in revamping ASPR's.

The DOD plan places increased emphasis on contracts which encourage good performance, with penalties provided for substandard effort.

## Shots of the Week

An Air Force *Blue Scout Junior* rocket successfully carried a 29-lb.



## Flex Wing Recovery Mode Tested

*FLYING TEST BED* of the Rogallo-based Ryan Flex Wing is now undergoing wind-tunnel tests at NASA's Langley Research Center. The wing is being studied as one method for recovering large rocket boosters and spacecraft.

package of radiation-measuring instruments over the South Pole after launch from Point Arguello, Calif., on Dec. 4.

The rocket reached its apogee of 27,600 mi., relaying back information on space radiation before plunging to destruction in the earth's atmosphere. In addition to instruments for measurement of low-energy protons from the sun, the package carried a new telemetry system broadcasting signals on less power than needed to operate flashlight bulbs. Scientific instruments included six "open window" photo-multiplier tube-type detectors and two solid-state detectors.

Launch of the *Blue Scout* was the first from the Pacific Missile Range. Seven previous launches were from Cape Canaveral. Ford's Aeronutronic Division is systems engineer and payload carrier contractor to the Air Force on *Blue Scout*.

Other military launchings:

- An *Atlas* dumped a load of dummy nuclear fuel cores into the atmosphere during re-entry after a 5000-mi. flight on Dec. 1. The fiery test was to determine how radioactive generators aboard satellites will burn up and disperse on re-entry.

- A Lockheed *Polaris* was fired more than 1000 mi. from Cape Ca-

naveral on Dec. 1 in another re-entry test. Firing was from a stable pad on the Cape. The ship-simulator launch facility now is being dismantled.

- A Martin *Pershing* scored its seventh straight success in another Dec. 1. launch from the Cape. The Army said the two-stage missile landed "squarely on target." It was the 23rd success in 27 shots.

- Air Force efforts to launch a Martin *Titan* at Vandenberg Air Force Base again were unsuccessful on Dec. 2 when "technical difficulties" forced postponement.

- Two Marquardt advanced *Roksonde* meteorological sounding rockets were successfully fired at Cape Canaveral on Dec. 1-2. The rockets, equipped with a microminiature telemetering payload, provided data on wind measurement and temperatures at altitudes exceeding 180,000 ft. Marquardt Corp. said the flights followed 14 successful flights of production *Roksondes* at White Sands Proving Grounds, N.M., and the Pacific Missile Range. Initial production *Roksondes* are being delivered to the Army Signal Corps.

## MA-6 Loses Race with Calendar

U.S. hopes of matching the Russian missiles and rockets, December 11, 1961



sian feat of putting a man into earth orbit this year were crushed finally last week when NASA announced the flight would not be attempted until sometime in January.

Informed sources said that the earliest possible date for the shot is now the second week in January. (See M/R, July 24, p. 16).

Technical difficulties or bad weather could put the launch off until late in the month.

There were two apparent reasons for the slippage. One was some unexpected trouble with the capsule's wiring. The other was the fear of Administration and NASA officials that a crash program to make the flight this year could endanger the life of Astronaut John Glenn, Jr., who has been selected to make the first manned orbital flight.

## Late Contract Awards

Pentagon contract awards in the missile/space field last week included a total of more than \$121 million for some 13 firms.

Two Air Force contracts for \$80 million are going to General Dynamics/Astronautics for work on the *Atlas*. Of this, \$65 million is for inspection and checkout of *Atlas* silo squadrons. The other \$15,369,063 is for production of *Atlas* ground equipment. The \$65-million contract is in addition to a \$93,369,586 contract already held by General Dynamics for activation of seven *Atlas* silo squadrons.

Lockheed Aircraft Corp. received a \$9,136,605 Air Force contract for continued production and installation of tracking and communications equipment for such Lockheed-built satellites as *Discoverer* and *Midas*.

Western Electric Co. received two Army contracts for the *Nike-Hercules*. One, for \$8 million, provides for improved high-performance radar. Work is to be done in Western Electric plants in Burlington, N.C., and General Electric plants in Syracuse, N.Y. A \$6,349,192 contract is for ground control and guidance equipment to be produced at Burlington, at Douglas Aircraft Co. in Santa Monica, Calif., and at Continental Can Co. in Chicago.

Raytheon Co. received \$5 million in Army contracts for the *Hawk* system. Ground support equipment will be built at Andover, Waltham and Dighton, Mass., under a \$4-million

missiles and rockets, December 11, 1961

contract; further research and development on *Hawk* will be carried on at Bedford and Wayland, Mass., under a \$1-million award.

American Bosch Arma Corp. received a \$2,035,000 Air Force contract for research and development on the *Atlas* inertial guidance system.

McKiernan-Terry Corp. was awarded \$1,771,660 for five gyroscopic stabilizers for the Navy's *Polaris* submarines.

Allis-Chalmers Manufacturing Co. won a \$1,251,926 contract for manufacture of diesel generators for the *Minuteman* installation at Ellsworth AFB, S.D. The company said the work will be done in Harvey, Ill.

Space Technology Laboratories received a \$1,197,000 Air Force contract to investigate the theory of interception of enemy missiles with orbital antimissile weapons.

West Bend Co. of Wisconsin won a \$1,881,600 Navy contract for the production of *Zuni* rocket launchers.

Federal Electric Corp. received a \$4-million Air Force award for installation of a long-range scatter communications system.

AC Spark Plug division of General Motors was awarded a \$1,877,516 Navy contract for internal components of the *Polaris* guidance system.

For more contract news, see p. 48.

## NASA Gets ComSat Advice

F. W. Godsey Jr., retired president of Electronic Communications Inc. and former vice president of Westinghouse Electric Co., has joined NASA as a consultant.

The space agency said his initial duties will be to assist in the development of policies and programs leading to a world-wide communications satellite system. He also will expedite the feedback of new devices, materials, and techniques into business and industry and advise on procurement policies and procedures designed to improve NASA's procurement system.

Godsey retired as president of Electronic Communications Inc. this year. Prior to that position, he served as manager of the Westinghouse Special Development Division, manager of its Baltimore Divisions and as vice president from 1940-56.

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# Wilson Calls Renewed

**Retired Air Force Chief also sees  
Dyna-Soar as 'most important,' ASP 'inevitable'**



**LT. GEN. R. C. WILSON (RET.)**  
*"... instinctive suspicion of bureaucracy"*

THE GENERAL who directed all Air Force research for the last three and a half years is urgently calling for the early resumption of U.S. nuclear testing in the atmosphere.

"Nuclear testing is critical—absolutely critical," Lt. Gen. Roscoe C. Wilson said in an interview after retiring as Air Force Deputy Chief of Staff for Research and Technology. "It is critical not only in military terms—in which it is critical indeed—but in terms of long-range progress in general."

Wilson, newly-named president of Allied Research Associates of Boston, retired from the Air Force on Dec. 1. He was succeeded as Deputy Chief of Staff by Lt. Gen. James Ferguson, vice commander of the Air Force Systems Command.

In recent weeks there have been strong indications that President Kennedy will order the resumption of U.S. nuclear tests in the atmosphere within the next few months.

Air Force and other military officials have joined with a growing number of congressmen and civilian experts in arguing for early resumption—particularly since the Russians broke the moratorium this fall. Wilson's statement is

one of the strongest on the subject by a top military man to date.

• **ASP inevitable**—Wilson also spoke out on a number of other programs and areas of research with which he has been closely associated. He said:

—"Dyna-Soar is the most important single program that the Air Force has. If man is going to be able to exploit space—in the sense of man-in-space—this is the way to do it. Otherwise, we are going to have a tough time talking about spaceships."

—"An Aerospace Plane is an inevitable development. If we don't pursue the technology that is going to give us one, then we are not taking advantage of what we can do."

—"ICBM development is far from ended. I can see four generations of ICBM's now. They will become smaller and more mobile. But that doesn't mean we won't find it necessary to have some heavy artillery."

—"The Air Force has a need for a whole family of boosters and upper stages—solids, liquids, and beyond these, other forms of propulsion. In solids there is a tremendous future. We shouldn't do anything that slows down the development of big solids."

## New R & D Boss Has Diverse Background

THE AIR FORCE'S new Deputy Chief of Staff for Research and Technology—Lt. Gen. James Ferguson—was born in the unlikely town of Smyrna, Turkey, of British parents the year before the outbreak of World War I.

His father, a businessman, was interned and the Fergusons remained in Turkey throughout the war and stayed on until revolution forced them to leave in 1923. They moved first to Scotland, then to California.

The next time General Ferguson visited Turkey was in 1947 as a military officer attached to the American Aid Mission to the Turks. The years between had been

highly eventful.

Ferguson enlisted in the Air Corps in 1934 after being graduated from Fullerton Junior College. After the outbreak of World War II, he trained P-47 groups and finally went to Europe with one.

"I arrived in time for the pre-invasion strikes and Normandy," he recalled this week. "After that, I was with Patton and we all had quite a go across Europe."

"Then I went to the Pacific for the invasion of Japan. But Hiroshima came along and they said, 'Thank you, we don't need you now' and sent me home. I didn't object at all."

The 48-year-old general, an impeccable, well-groomed man with a military mustache, sat in his new office and talked incisively and easily.

For the last several years, he and his wife have lived at Andrews AFB, Md., near the Air Force Systems Command Headquarters where he has been vice com-

missiles and rockets, December 11, 1961



# Nuclear Tests 'Critical'

by James Baar

—Despite statements to the contrary by some people, "the Air Force has some very firm goals in space." The Air Force has "military requirements in space that have been carefully put together over a long, long time. In the light of this, I won't pretend that the Air Force has been happy over the way things have gone."

Wilson, one of the Air Force's most literary-minded generals, spoke in his usual low, cultured tones. He wore a well-tailored business suit. As he talked, he sat at ease in a comfortable swivel chair in a Washington office and smoked cigarettes.

His comments on nuclear testing were particularly well-founded on long experience in the field. His work in nuclear bomb development dates back to World War II when he served as the Air Force liaison officer with the Manhattan District.

• **Extrapolators' dilemma** — "To fully appreciate the importance of nuclear power development," he said, "you have to think in terms of energy. Energy is the key to our modern living. And the improvement of this key to meet our coming demands is certainly beyond the possibilities in chemical power."

"The promise of nuclear power is very great. But we really don't know too much about it. We have just started to develop the knowledge we need in this area. And there are some avenues that you simply can not approach without testing—without explosions."

Nor, Wilson made clear, were underground nuclear tests sufficient.

"Underground testing puts us under very considerable restraints," he said. "You are confined to the underground environment. You are limited in terms of magnitude. And there is a serious cost penalty. If we want to perform all the tests we need, we still must go into the atmosphere."

"We already have had to make extrapolations. There comes a time when you have to put these theories to some sort of test or you face the same situation as the medieval schoolman. For reasons other than moratoria, he had a guy named Aristotle."

Wilson shrugged and laughed.

"How would anyone have ever developed the gasoline engine if testing gasoline combustion had been forbidden?"

• **Seeds of superannuation**—Turn-

ing to the East-West race into space, Wilson repeated what he has said in the past: That Russia is driving toward military control in space, but that the United States still could head off the Russian threat.

"We forced ourselves into a position of broadening our knowledge, sharpening our processes," he said. "This knowledge is stronger today. It has more reliability."

"We start with a broader technological base. And we also have a big advantage over the Russian bureaucracy because of our political system. I have an instinctive suspicion of bureaucracy. It has in it certain latent seeds of its own superannuation in that over the years it adopts the 'not invented here' philosophy. We're saved from this sooner or later by the periodic turnovers caused by the electorate."

Then Wilson, who has had considerable experience in no small bureaucratic organization, added:

"You do best when a lot of little companies are pounding on the door with fresh ideas. Where are the people pounding on the door when the ideas run out in the Soviet bureaucracy?" ❧



Lt. Gen. James Ferguson

mander since 1959. He likes to grow vegetables. He is interested in geography. He likes to read travel books.

"I have an old map of the world on which I've circled all of the airports where I've been," he said. "About the only place where I don't have any circles is central India."

In the first years after World War II, Ferguson's travel was somewhat curtailed while he taught tactical operations at the Air University. Then he went to Turkey; then Korea. During the Korean War, he served as vice commander of the Fifth Air Force.

He formally got into the R&D business in 1955 when he became deputy requirements director and later director in the Office of the Deputy Chief of Staff for Development. In 1959, he was transferred as vice commander to the Systems Command.

"But even in the combat operations business you're always getting involved with development," he said. "In the field you find yourself lashing things up all the time." ❧

# Electronics Gain in Latest 'Top 100'

THE DEFENSE Department's newly released List of 100 Top Prime Contractors for FY '61 gave new evidence of the upward trend in electronic lines in the Missile/Space Industry.

The giant General Dynamics Corp. again easily held the No. 1 slot as it has four times in the last five years. GD also increased its share of the total awards from 6 to 8.5%.

North American Aviation surged upward from fifth to second place, jumping ahead of Lockheed, Boeing and GE. Each of the latter dropped one place to third, fourth and fifth respectively.

But one of the biggest shakeups came in the bottom ranks of the List's Big Ten: Sperry Rand moved from 13th to ninth place while Douglas fell from 10th to 14th.

Other major changes included the rise of Westinghouse Electric from 16th to 13th (M/R, Nov. 13), Thiokol from 29th to 24th, AMF from 56th to 30th and Ford from 81st to 43rd.

The List showed that the total of FY '61 prime military contracts over \$10,000 rose to \$22.69 billion—a jump of \$1.69 billion over FY '60. Of this the Big Ten received 38.6%.

## Pentagon List of FY '61 100 Top Prime Contractors

| FY '61 Rank | COMPANY                             | FY '61 Contracts (in millions) | FY '60 Contracts (in millions) | FY '61 Rank | COMPANY                            | FY '61 Contracts (in millions) | FY '60 Contracts (in millions) |            |
|-------------|-------------------------------------|--------------------------------|--------------------------------|-------------|------------------------------------|--------------------------------|--------------------------------|------------|
| 1           | (1)* General Dynamics Corp.         | 1,920.1                        | 1,260.2                        | 51          | (95) International Harvester Co.   | 63.1                           | 25.6                           |            |
| 2           | (5) North American Aviation, Inc.   | 1,197.4                        | 907.7                          | 52          | (66) Sanders Associates, Inc.      | 63.1                           | 40.9                           |            |
| 3           | (2) Lockheed Aircraft Corp.         | 1,175.2                        | 1,070.8                        | 53          | (39) Goodyear Tire & Rubber Co.    | 62.6                           | 84.7                           |            |
| 4           | (3) Boeing Co.                      | 919.8                          | 1,008.7                        | 54          | Not Listed                         | Fuller (G.L.) & Webb (D.E.)    | 62.1                           | Not Listed |
| 5           | (4) General Electric Co.            | 874.6                          | 963.1                          | 55          | (64) Gen'l Telephone & Electronics | 61.4                           | 43.6                           |            |
| 6           | (6) Martin Co. (The)                | 691.8                          | 596.7                          | 56          | (43) Garrett Corp.                 | 59.9                           | 71.5                           |            |
| 7           | (7) United Aircraft Corp.           | 625.5                          | 517.4                          | 57          | (62) Shell Caribbean Petroleum Co. | 56.9                           | 44.8                           |            |
| 8           | (8) AT&T                            | 550.6                          | 466.8                          | 58          | (47) Socony Mobil Oil Co., Inc.    | 52.9                           | 64.6                           |            |
| 9           | (13) Sperry Rand Corp.              | 408.0                          | 296.0                          | 59          | (69) Olin Mathieson Chemical Corp. | 52.9                           | 38.1                           |            |
| 10          | (9) Radio Corp. of America          | 392.3                          | 405.8                          | 60          | (65) Lear, Inc.                    | 50.2                           | 43.2                           |            |
| 11          | (11) Hughes Aircraft Co.            | 331.2                          | 349.1                          | 61          | (50) Ling-Temco Electronics, Inc.  | 46.8                           | 61.9                           |            |
| 12          | (14) I B M                          | 330.0                          | 290.0                          | 62          | (59) Morrison-Knudsen Co.          | 45.6                           | 46.0                           |            |
| 13          | (16) Westinghouse Electric Corp.    | 307.7                          | 257.6                          | 63          | (73) Johns Hopkins University      | 44.6                           | 34.8                           |            |
| 14          | (10) Douglas Aircraft Co.           | 307.4                          | 404.9                          | 64          | (98) Eby (Martin K.) Construction  | 42.1                           | 23.7                           |            |
| 15          | (12) Raytheon Co.                   | 304.9                          | 323.4                          | 65          | (46) Ryan Aeronautical Co.         | 42.0                           | 65.5                           |            |
| 16          | (15) Republic Aviation              | 295.7                          | 265.1                          | 66          | (74) DuPont (E.I.) de Nemours Co.  | 41.1                           | 34.5                           |            |
| 17          | (17) General Tire & Rubber Co.      | 290.2                          | 243.2                          | 67          | Not Listed                         | Todd Shipyards Corp.           | 40.6                           | Not Listed |
| 18          | (21) Newport News Ship              | 290.2                          | 215.2                          | 68          | (58) Kaman Aircraft Corp.          | 40.2                           | 46.6                           |            |
| 19          | (20) General Motors Corp.           | 281.8                          | 218.7                          | 69          | (91) Fairchild Stratots Corp.      | 39.8                           | 25.9                           |            |
| 20          | (18) Bendix Corp.                   | 266.8                          | 239.4                          | 70          | Not Listed                         | Eastman Kodak Co.              | 38.3                           | Not Listed |
| 21          | (26) Avco Corp.                     | 251.6                          | 156.9                          | 71          | Not Listed                         | Marine Transport Line, Inc.    | 37.2                           | Not Listed |
| 22          | (19) Grumman                        | 238.0                          | 239.3                          | 72          | (72) System Development Corp.      | 36.7                           | 35.2                           |            |
| 23          | (22) McDonnell Aircraft Corp.       | 219.9                          | 195.0                          | 73          | (71) Mason & Hanger—Silas Mason    | 36.5                           | 36.0                           |            |
| 24          | (29) Thiokol Chemical Corp.         | 210.0                          | 131.2                          | 74          | Not Listed                         | Fluor Corp. Ltd.               | 35.6                           | Not Listed |
| 25          | (23) IT&T                           | 201.6                          | 188.5                          | 75          | Not Listed                         | Aerospace Corp.                | 34.8                           | Not Listed |
| 26          | (25) Standard Oil Co. (New Jersey)  | 167.7                          | 173.5                          | 76          | (83) Richfield Oil Corp.           | 34.3                           | 29.8                           |            |
| 27          | (24) Chrysler Corp.                 | 158.2                          | 187.0                          | 77          | Not Listed                         | Kewanee Oil Co.                | 34.3                           | Not Listed |
| 28          | (28) Northrop Corp.                 | 155.6                          | 139.8                          | 78          | (67) Continental Oil Co.           | 33.7                           | 39.6                           |            |
| 29          | (35) Pan-American                   | 127.4                          | 95.6                           | 79          | (60) Magnavox Co.                  | 32.4                           | 45.3                           |            |
| 30          | (56) American Machine & Foundry Co. | 119.8                          | 50.0                           | 80          | (93) Standard Kollsman Industries  | 32.2                           | 25.7                           |            |
| 31          | (36) Philco Corp.                   | 118.8                          | 95.2                           | 81          | Not Listed                         | Standard Oil Co. (Indiana)     | 31.6                           | Not Listed |
| 32          | (37) Hercules Powder Co.            | 117.0                          | 92.2                           | 82          | Not Listed                         | Fuller-Webb-Hardeman           | 31.1                           | Not Listed |
| 33          | (30) Burroughs Corp.                | 111.5                          | 125.1                          | 83          | Not Listed                         | Northern Pump Co.              | 30.6                           | Not Listed |
| 34          | (32) Standard Oil Co. of California | 109.4                          | 110.7                          | 84          | Not Listed                         | Keystone Shipping Co.          | 30.6                           | Not Listed |
| 35          | (44) American Bosch Arma Corp.      | 107.6                          | 70.7                           | 85          | (63) Laboratory for Electronics    | 29.7                           | 44.3                           |            |
| 36          | (27) Chance Vought Corp.            | 102.5                          | 141.9                          | 86          | Not Listed                         | Ingalls Iron Works Co.         | 29.6                           | Not Listed |
| 37          | (33) Collins Radio Co.              | 94.0                           | 103.1                          | 87          | (61) Hazeltine Corp.               | 29.5                           | 44.9                           |            |
| 38          | (57) F M C                          | 87.9                           | 46.7                           | 88          | Not Listed                         | Midland Constructors, Inc.     | 28.9                           | Not Listed |
| 39          | (40) Texaco, Inc.                   | 85.5                           | 76.8                           | 89          | Not Listed                         | White Motor Co.                | 28.7                           | Not Listed |
| 40          | (34) Minneapolis-Honeywell          | 85.5                           | 97.5                           | 90          | Not Listed                         | Vitro Corp. of America         | 28.4                           | Not Listed |
| 41          | (55) M I T                          | 82.5                           | 50.6                           | 91          | (92) Firestone Tire & Rubber Co.   | 28.2                           | 25.9                           |            |
| 42          | (42) General Precision Equipment    | 81.3                           | 71.9                           | 92          | Not Listed                         | Jones-Teer-Winkelman           | 28.1                           | Not Listed |
| 43          | (81) Ford Motor Co.                 | 81.0                           | 30.5                           | 93          | (86) Cook Electric Co.             | 28.1                           | 28.3                           |            |
| 44          | (49) Bethlehem Steel Corp.          | 79.4                           | 62.2                           | 94          | Not Listed                         | Universal American Corp.       | 27.9                           | Not Listed |
| 45          | (31) Thompson Ramo Wooldridge Inc.  | 76.9                           | 120.8                          | 95          | (68) Westinghouse Air Brake Co.    | 27.9                           | 39.5                           |            |
| 46          | Not Listed                          | 73.1                           | Not Listed                     | 96          | Not Listed                         | Sinclair Oil Corp.             | 26.8                           | Not Listed |
| 47          | (45) Curtiss-Wright Corp.           | 69.8                           | 70.4                           | 97          | (90) ARO, Inc.                     | 26.4                           | 26.5                           |            |
| 48          | Not Listed                          | 68.9                           | Not Listed                     | 98          | (53) Marquardt Corp.               | 26.3                           | 52.2                           |            |
| 49          | (48) Continental Motors Corp.       | 68.4                           | 63.1                           | 99          | Not Listed                         | Texas Instruments, Inc.        | 26.2                           | Not Listed |
| 50          | Not Listed                          | 65.8                           | Not Listed                     | 100         | (76) Motorola, Inc.                | 25.6                           | 34.1                           |            |

\*Position in FY '60



# Nuclear Rocket Pricetag: \$1 Billion

by Hal Taylor

TOTAL COST of developing nuclear rocket upper stages for the U.S. space program is being pegged at well over \$1 billion. It's also now pretty certain they won't be ready for manned nuclear lunar flights until 1968-69.

The big push in funding is starting in FY '63. Harold B. Finger, manager of the joint NASA-AEC Space Nuclear Propulsion Office, says the forthcoming budget request will be \$200 million, more than double the \$90-million FY '62 appropriation. (Through FY '62, about \$280 million will have been spent on the nuclear rocket program.)

Finger estimates that by the time the first nuclear stage is launched in 1966-67 the program will have cost \$1 billion. But he adds: "It will be two more years, or 1968-69, before the stage is operational."

The program director said in an interview that delays in the current series of reactor tests have just about killed off chances for employing nuclear power in a 1967 lunar landing.

"There is still a slim possibility," said Finger, "but it is so negligible that it's not worth talking about."

In other developments last week:

—NASA invited 28 firms to attend a proposal conference on the prime contract to develop and test the nuclear stage.

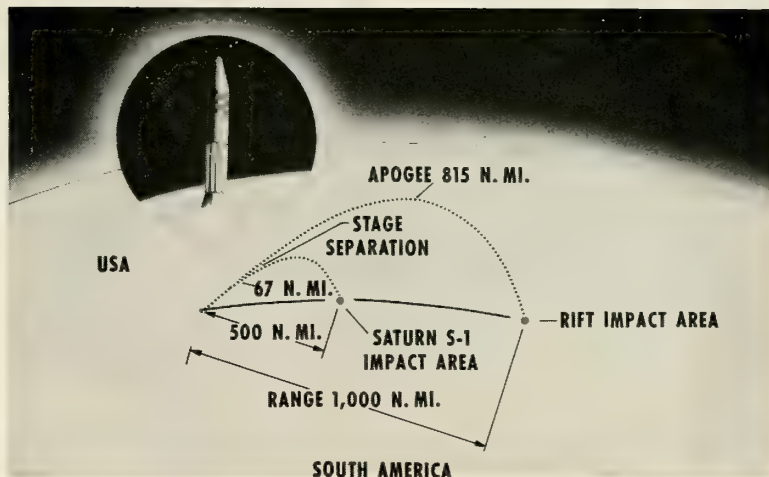
—It announced that a series of tests on the Kiwi B reactor—leading to development of the *NERVA* nuclear rocket engine—will be resumed shortly despite a recent explosion at the Nevada test site.

—The Aetron Division of Aerojet General Corp. was selected to do the architectural and engineering work for a downfiring nuclear engine test stand at the AEC's Nevada facility. The facility—funded by NASA—will cost \$8 million. Aetron will get about 10% of that figure.

• **What went wrong**—Space agency officials told Congress during the last session that it might be possible to test-launch nuclear upper stages in 1965. That date would have permitted their use in *Apollo* as early as 1967—NASA's target date for a manned lunar landing.

This was premised, however, on the perfect execution of a series of reactor tests scheduled to begin last October.

The tests have slipped some two



FIRST NUCLEAR ROCKET flights are due to be made from Cape Canaveral in 1966-67. Operational version is expected to be ready two years later.

months, with technical difficulties and a recent hydrogen gas explosion as the chief causes of the delay.

Thus, the first full-power run of the Kiwi-B1A reactor using liquid hydrogen will not take place for one and perhaps two weeks.

At this point, Finger said the chances for a 1965 launch date are extremely slim, if not impossible.

The recent explosion destroyed auxiliary pipes and instruments, but apparently did no damage to the reactor itself. Restoration of equipment and instruments checks are continuing. If nothing adverse develops, the test program will be resumed and will run through the most of 1962.

Following the gaseous hydrogen runs, a test using liquid hydrogen as the propellant will begin early next year.

Once the test series is concluded successfully, final design and development of the *NERVA* nuclear rocket engine will be started by the system's prime contractors, Westinghouse Electric Co. and Aerojet-General Corp.

The engine will then be fabricated into the nuclear upper stage by the prime contractor for the Reactor-in-Flight-Test (RIFT) program.

In announcing that 28 firms had been invited to the proposal conference, NASA said that the Marshall Space Flight Center will contract for the design, development, research fabrication and testing of the RIFT vehicle.

• **Two-stage elimination**—Selection of the contractor will be in two parts. At a meeting last week potential bidders were given general information to permit them to determine whether they were interested in doing the work. If they elect to enter the competition, initial proposals will be due at the Marshall Center within 30 days.

The initial proposals will contain information on the firm's capabilities and experience. After the first proposals are evaluated, a lesser number of firms will be invited by NASA to submit detailed offers including cost information and technical approach based on complete specifications given them at the end of the first phase.

The 28 firms invited to attend the preproposal conference are Avco Corp.; Boeing Airplane Co.; Bell Aircraft Co.; Beech Aircraft Corp.; Bendix Aviation Corp.; Chrysler Corp.; Douglas Aircraft Co.; Ford Motor Co.; General Dynamics/Astronautics; General Electric Co.; Goodyear Aircraft Corp.; Grumman Aircraft Engineering Corp.; Hughes Aircraft Co.; Ling-Temco-Vought, Inc.; Lockheed Aircraft Corp.; Martin Co.; McDonnell Aircraft Corp.; North American Aviation, Inc.; Minneapolis-Honeywell Co.; Northrop Corp.; Raytheon Co.; Republic Aviation Corp.; Ryan Aeronautical Corp.; Space General Corp.; Space Technology Laboratories, Inc.; Sperry Rand Corp.; United Aircraft Corp.; Westinghouse Corp. ■

## Special Report

In the next few weeks the Special Bioastronautics Committee of the National Aeronautics and Space Council will be writing the future of all bioastronautical research in the United States. The panel must decide: Does duplication exist? What new facilities must be built? And above all—who gets this key research assignment—NASA or the Air Force?

For an insight into the morass of problems facing the panel, M/R on these pages presents the views of three acknowledged experts in the field of

space medicine.

Congressman Emilio Q. Daddario (D-Conn.) is an active member of the House Committee on Science and Astronautics. He particularly has been a student of the problems of the bioastronautical aspects of spaceflight, and has made visits to almost all U.S. installations doing bioastronautical research.

Dr. James N. Waggoner is Aerospace Medical Director of The Garrett Corp. and was chairman of the Aerospace Medical Association convention in Chicago this spring. Dr. John L. Mason is chief engineer of The Garrett Corp.

by Congressman Emilio Q. Daddario

# 'A Long Way to Go' in Organization

THE SPRAWL of scientific research activities throughout the Federal Government presents a complicated picture which deserves our closest attention. Nothing is more important than that we organize the use and direction of our resources for technological change so that we utilize them effectively and with the least waste.

One area in which this is glaringly apparent is the field of bioastronautics, the life sciences in space.

The National Aeronautics and Space Act sets a clear and unequivocal obligation on the Federal Government to make the most effective utilization of the scientific and engineering resources of the United States with close cooperation among all interested agencies to avoid unnecessary duplication of effort, facilities, and equipment.

But that's easier said than done. When the space program was stepped up, in 1957 following *Sputnik*, another scientific scramble was already under way. This was the scramble in life sciences, mapping out programs, commissioning laboratory work, seeking out qualified help. In Fiscal 1961, some 10 agencies were engaged in some kind of biomedical research.

NASA, charged with the responsibility for manned space flight, undertook to set up and program its own research in the life sciences. My attention was attracted to the apparent total independence of, and indifference to, the existing facilities and work in prog-

ress evidenced by the NASA program and I have maintained an interest ever since.

I think we still have a long way to go. When I surveyed the scope of facilities and personnel available to this country in the field of space life sciences, I was struck by two factors: First, the limited number of skilled personnel available to meet the multitude of questions churning forth, and, second, the developed state of programs in this country and abroad in which knowledge and experience had been assembled in the national interest.

• **Air Force changes**—I believed a strong effort was warranted to sort out this array and secure an integrated effort. We have made considerable progress since that date. The Air Force, whose programs had grown to meet a very real national security challenge, came to accept the fact that its organization needed rethinking. Lt. General James E. Briggs, Chief of the Air Training Command, disclosed in September that the Air Force had moved to consolidate its own aerospace research facilities.

At the same time, a national effort is under way to survey all space medical resources and make better utilization possible. How soon the report and recommendations may be ready, I do not know, but I am looking forward to them with interest. This study started with the basic assumption that there is a need to bring order to this research,

and is being conducted with responsibility.

• **Military and civil need**—Obviously, the most important job is one of management on a national scale. We cannot neglect the fact that the uses of the atmosphere and space are potentially both military and civilian.

The services cannot stop studying the effect of extremes of speed and temperature on man, nor can they give up their interest in the unusual environments in which he may be called upon to defend his country. Nor can the National Aeronautics and Space Administration wait upon all others to submit their reports before they plan the peaceful exploration and exploitation of space.

These facts lead inevitably and always to the same answer: If we are to use our resources wisely and determine our answers effectively and speedily, we must insist on the maximum of teamwork in programming and execution.

The Air Force has acquired considerable experience in the use of private institutions and private industry in studying its problems. I pointed out the extent of this capacity in my report to the House Committee on Science and Astronautics. NASA, working from a different approach, is building up such a capability. In combination, NASA, and DOD have the people and facilities from which to build our national effort.

I have pointed this out consistently

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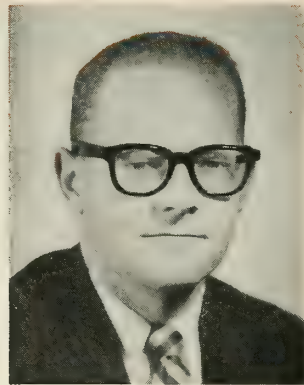




DADDARIO



WAGGONER



MASON

by Dr. James N. Waggoner, M.D., and Dr. John L. Mason

## Goal: Safety and Less Duplication

THERE IS an immense task in bioastronautics before the United States now, if we are to meet our present goals.

Duplication of scientific data is always desirable, but we cannot afford the luxury of unnecessary duplication in achieving these needed pieces of information in the short amount of time available. We must further coordinate all areas of our bioastronautic effort to be sure only the required amount of repeat work is being done.

There can be no compromise with the health and safety of human occupants of our space vehicles. To ensure this, three considerations must be thoroughly evaluated: 1) all hazards, actual and potential, the human body must face while in space; 2) the human reaction to these stresses; and 3) all special provisions necessary to prevent any adverse reaction on the part of the human to these potential dangers.

Supporting life in space does not necessarily mean that we must totally duplicate an ideal sea-level atmosphere. Certain compromises can be made which will not interfere with the human's physical or mental performance capabilities.

For example, there is every reason to believe that a human can safely tolerate only  $\frac{1}{2}$  the total gas pressure present at sea level, as long as the oxygen content is maintained at a sea-level equivalent. Several other compromises may be possible to facilitate the engi-

neering and construction of the space vehicle in the short amount of time available. However, these must be very carefully chosen so that they never interfere with the human's tolerance and, in fact, comfort level.

The space occupant will be performing vital, decision-making, on-the-spot tasks. No distraction from such things as significant temperature and humidity variations can be allowed.

• **Ground laboratory tests**—There are many experiments which can be, and are being carried out at sea level to increase our knowledge regarding man's capabilities in space. One example is a consideration of the human tolerance to various partial and total pressures other than the normal 80/20 nitrogen-oxygen mixture.

We need to increase our knowledge regarding definitive human reaction to a variety of total gas pressures; furthermore, we can simulate at sea level the physiological reaction to sudden reductions in total pressure that would be encountered in space were an emergency to occur.

Our knowledge regarding man's reaction to various partial pressures of oxygen lower than normal seems to be quite adequate. We could learn more about his reaction to oxygen-rich atmosphere for prolonged periods of time.

Our present knowledge regarding the occurrence of aeroembolism, or the bends, following exposure to oxygen-nitrogen mixtures other than those seen

at sea-level, is extremely limited. Such knowledge is mandatory in our design of the emergency system in the space vehicle in the event of capsule pressurization failure.

These experiments may need to be carried out on animals, before man. In potentially dangerous situations, the only program is to totally evaluate an animal's reaction, even down to a cellular level, before taking any chances with a human subject.

These programs of necessity include a complete assay of the subject from every conceivable viewpoint before, during and after the test. This means that, in some areas, we may need to increase our knowledge of the body as a whole and of its cells. The cooperation of Space Age facilities and modern teaching hospitals and medical schools of the country will be needed.

• **In-flight experiments**—There are three basic parameters which can only be investigated in flight: 1) human reactions to the weightless state; 2) physiological response to random radiation of space; 3) psychological reaction.

Zero gravity is a great unknown because of our very limited experience with it. Water-immersion tests have provided our only means to simulate weightlessness on earth, and this, of course, cannot duplicate the condition in its entirety. However, common sense, confirmed by the water-immersion tests conducted thus far, indicates quite

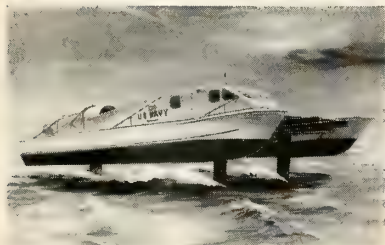
(Continued on page 38)



**AERIAL MISSILE LAUNCHER.** Photo shows Boeing B-52 missile bomber making in-flight launch of Hound Dog missile, which flies at supersonic speed toward target far ahead. In addition to missiles, versatile B-52s can carry regular bomb-bay load of

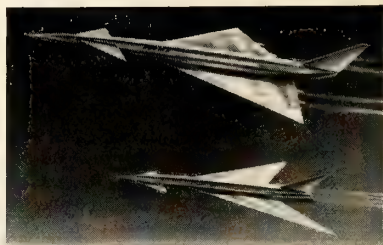
gravity bombs. New B-52H, with turbofan engines and sophisticated electronics, is tailored for wide variety of Strategic Air Command mission requirements. Later, B-52H will carry hypersonic Skybolt ballistic missiles, a 1000-mile weapon under development.

## *Capability has many faces at Boeing*



**JET HYDROFOIL.** Drawing shows jet-powered twin-hull test hydrofoil Boeing is designing and building for U.S. Navy. Hydrofoil will "fly" on under-water wings at 115 mph.

**TWIN-TURBINE** helicopter, Boeing-Vertol 107, seats 25 and will enter service soon with New York Airways. 107s have been ordered for service in Japan, Canada and Sweden. Military version is being built for U.S. Marine Corps.



**SUPersonic JETLINERS.** Boeing continues to invest substantial sums in supersonic jet transport research. Drawing shows two Boeing designs being studied. Supersonic jets would fly two to three times speed of sound, make flight from New York to London in under three hours.

# **BOEING**



# Technical Countdown

## ELECTRONICS

### ESG Studies Modified

Minneapolis-Honeywell's Air Force contract for development of an experimental guidance system employing electrically suspended gyros (ESG's) is being redirected toward evaluation of the gyro itself. Goal is to establish criteria now for future analysis and evaluation of ESG guidance systems. Development of the 2-in. inertial elements (M/R, Nov. 13, p. 30) for the Air Force is being carried out at the firm's St. Petersburg, Fla., plant.

### Astronauts Reported Best for G & C

Adequate manned control of space vehicles for close lunar orbiting and for direct-descent re-entry to earth is feasible, according to two recent technical reports by researchers at NASA's Langley Research Center. The first indicates that pilot control for a circular 10-mile lunar orbit is not only practical but will reduce greatly the complexity and weight of instruments needed for a similar unmanned mission. The other report, covering parabolic re-entry, concludes that piloted systems (simulated) show definite superiority for obtaining ranges in excess of the three other automatic re-entry techniques studied.

## SUPPORT EQUIPMENT

### AF Buys Weather Display System

An electroluminescent weather-information display system will be built by Sylvania's Waltham Laboratories for the Air Force Electronic Systems Div., Hanscom Field, Mass. Data transmitted from a series of AF observation sites to the weather center will be decoded and displayed in blue-green, 0.75-in.-high characters. Messages up to 72 characters in length will be handled. The prototype system is the forerunner of a massive display center to which all AF weather gathering stations may someday relay observations. Two display systems will be installed under the \$48,000 contract, the AF said.

### EIA Forecasts Radar Growth

Heavy radar market expansion over the next eight years was predicted by panelists at a recent Electronic Industries Association seminar in Los Angeles. Their estimates included: heavy surface radars—up from this year's \$500 million to \$775 million by 1970; aircraft and drone radars—up from \$127 million to \$215.4 million; shipboard radars—up from present \$110 million to \$150 million. ASW, range, and space exploration requirements will generate heavy growth in surface radar.

### Army Studying Laser Radar

Scientists at Fort Monmouth's Signal Corps R&D Laboratories are aggressively pursuing an application of laser beams to a radar-like device. By aiming the laser beam at an object and picking up the reflected energy in a telescopic sensor, the distance to the object can be measured precisely. Advantages of such a device, the scientists say, would include simplicity and small size as well as enhancement of present radar detection capabilities.

missiles and rockets, December 11, 1961

### Telestar Telemetry Station Delivered

The first ground telemetry station for AT&T's *Telestar* communications satellite has been delivered to Bell Labs' Hillside, N.J., site, according to Electro-Mechanical Research, Inc., builders of the PCM telemetry equipment. The equipment will receive, record, decommutate, display and print out 118 data channels. This information will be used to determine the optimum design parameters for the operational satellites.

### Computer Power Supply Announced

A compact and highly precise power supply—capable of regulating computer voltage levels to within 0.75%—has been developed for RCA's 601 computer, according to its developers, Airpax Electronics, Inc. The system uses transistor-driven magnetic amplifiers for voltage control of the total 13-kw load. Combining six separate voltages to make one power supply, the Airpax units can maintain precise control even though the line voltage may vary as much as 15% above or below the nominal value, the company said.

## ADVANCED MATERIALS

### Ultrasonic Welding Out for High-Temp Metals

An Air Force report turns thumbs down on applying ultrasonic welding to heat-resistant metals. "It appears," states the report, "that as a material's hardness increases and the ratio of tensile strength-to-yield strength decreases, weldability by the ultrasonic process decreases." The process is still recommended for aluminum and other relatively soft metals.

### Extrusion Die Temperatures Increase

Steel extrusion dies sprayed with aluminum oxide can withstand operating temperatures up to 3400°F without die-wash from refractory metals. Harvey Aluminum researchers predict the working temperatures can probably be ranged upwards to 4000°F through use of other coatings such as zirconium oxide or zirconium silicate. But lubricating the billets still remains a problem.

### More on Re-entry Ionization Heat

Armour Research Foundation scientists have developed an improved heat-transfer gage which extends the range of shock-tube thermal measurements. Its use in stagnation heating studies substantiates recent work of GE scientists showing that heat transfer is significantly increased due to the presence of ionized gases (M/R, Nov. 20, p. 14). The modified film gage neutralizes the ionized component and measures the total heat flux to the body and the purely convective flux.

### New Machine-use for Diamonds

Metals now are being burnished with diamonds—a new use for the high-priced carbon particles—says General Electric engineer E. H. Hull. He told a recent American Society of Mechanical Engineers meeting that diamond-burnishing produces smooth surface finish and work-hardened surface layers. Accuracy of the original surface is preserved or improved, since no metal is removed during the process. Uses seen are on journals to reduce bearing wear, and on surfaces to improve the leak-tightness of vacuum seals.



REACTION'S 10,000-lb.-thrust engine, here running on  $N_2O_4/MMH$ , could easily handle  $OF_2$  systems.

## propulsion engineering

# $OF_2$ Promising As Space-storable Fuel

by John F. Judge

SCIENTISTS at the Reaction Motors Division of Thiokol Chemical Corp. are perfecting oxygen difluoride as the lead item in a new family of space-storable propellants.

Recent selection and mission studies have shown that  $OF_2$  oxidizer bi-propellant systems have several distinct advantages over other high-performance propellants:

— $OF_2$  is unique in that it provides good performance with both carbonaceous

and non-carbonaceous fuels. Fluorine will not.

— $OF_2$  and its fuels provide a high propellant-combination bulk density, which results in more compact vehicles and less structural weight.

— $OF_2$  is extremely easy to store in space as compared to oxygen, fluorine and hydrogen.

— $OF_2$  systems do not need advanced hardware—the combinations will operate in currently developed liquid engines.

The propellant evolution has been under way at Reaction Motors for over

two years. Researchers looked for space-storable combinations having performance characteristics at least as good as liquid oxygen-hydrogen.

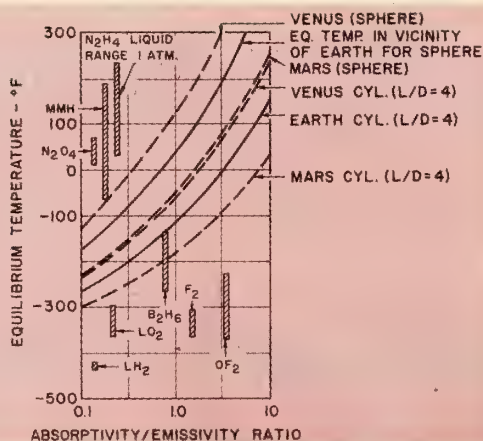
• **High nozzle ratios**—Since space propulsion systems were involved, low-gamma propellants were investigated. (Gamma is equal to the average ratio of specific heat at constant pressure to the specific heat at constant volume for gases in the exhaust nozzle.) At any given area ratio, an increased thrust coefficient can be shown for a lower gamma system.

Propulsion engines designed to operate in the vacuum of space or in the near-vacuum of higher altitudes can take full advantage of large area ratios and low-gamma systems to increase performance potential. The  $OF_2$  combinations are low-gamma systems.

Current storable systems were developed for nitrogen peroxide/monomethyl hydrazine combinations. RMD upgrading moves next to  $OF_2/MMH$  and then to  $OF_2$ /diborane—getting performance increases simply through swapping propellants.

Reaction has fired the  $OF_2/MMH$  combination in radiative-cooled 5-lb. thrust engines and regeneratively-cooled 100-lb.-thrust engines and achieved performance factors greater than 98% theoretical. The engines were originally designed for  $N_2O_4/MMH$ .

Besides their high performance characteristics,  $OF_2$  systems have a higher

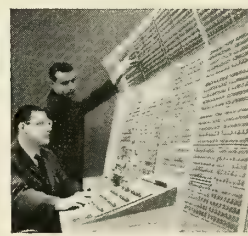
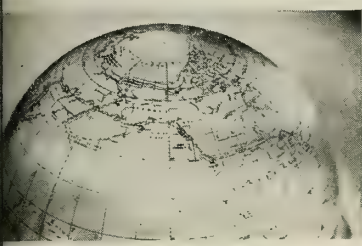


Equilibrium Temperatures in Space



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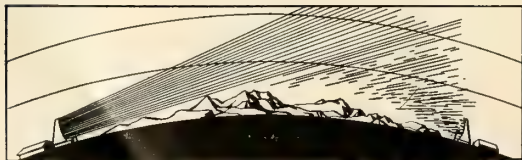
- |                                     |                     |
|-------------------------------------|---------------------|
| HEADQUARTERS .....                  | ROCKVILLE, MARYLAND |
| SYSTEMS CENTER .....                | BETHESDA, MARYLAND  |
| SPACE GUIDANCE CENTER .....         | OWEGO, NEW YORK     |
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## **ALERT: Litton Communication Systems Advance the Defense Posture of the Free World**

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density than many similar cryogenic systems. In a typical Saturn upper stage, OF<sub>2</sub> systems can reduce tankage from 220-in.-diameter and 320-in.-high to a compact sphere 142 in. across—all other factors considered.

If a reduction of this magnitude is applied to two or more upper stages, there is a significant decrease in overall vehicle size, resulting in obvious weight savings.

Shrouding reductions made possible through substitution of OF<sub>2</sub> systems for the liquid O<sub>2</sub>-H<sub>2</sub> in an Apollo-type vehicle would shorten the craft by almost .7 feet.

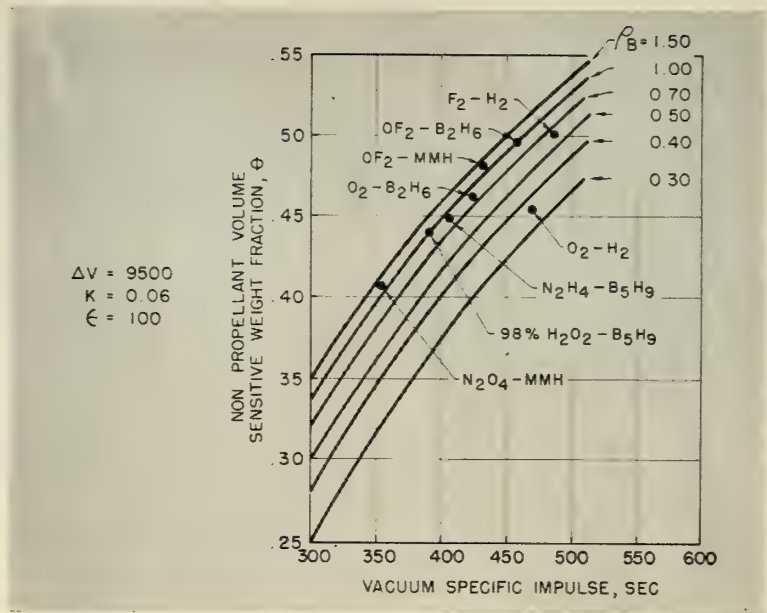
• **Storability factor**—Reaction scientists say it is possible to establish equilibrium temperatures in a vehicle below the boiling points of the storable propellants and within a fair range of absorptivity/emissivity ratio. The equilibrium temperature of a body in space is a function of its surface finish, its orientation and surface area with respect to the sun and the magnitude of the incident solar flux.

Under equilibrium with solar flux there is always a temperature difference between liquid hydrogen and the vehicle skin. With proper stage orientation and surface finish control the two OF<sub>2</sub> propellant combinations may be stored indefinitely in the liquid state.

Much has been published on the problems of storing liquid hydrogen in space and the complex insulation, orientation and surface finish systems proposed. But there still remains the problem of propellant boil-off venting under zero-g conditions. OF<sub>2</sub> systems do not have to be vented and this, in turn, simplifies the propellant feed design.

Another aspect is a common liquid range in the OF<sub>2</sub> systems. This means that common bulkheads may be used without insulating barriers. Again the result is less weight, a more compact arrangement and simplicity of construction.

• **Classic compound**—All the OF<sub>2</sub> systems are hypergolic. Reaction Motors



*I<sub>sp</sub>/DENSITY chart shows vehicle payload capability. Note OF<sub>2</sub>/MMH, O<sub>2</sub>-H<sub>2</sub> positions.*

fired a 150-lb.-thrust engine involving OF<sub>2</sub>/diborane and water cooled to check out hypergolic characteristics and to rate against the theoretical performance. There were two firings, both smoothly hypergolic and both reaching over 96% of the theoretical performance.

OF<sub>2</sub> itself is an old compound. It is relatively stable at room temperature, breaking down into oxygen and fluorine at elevated temperatures. It is relatively inert when compared to elemental fluorine, but information on specific compatibility is limited. RMD has a going program to evaluate the corrosion characteristics of the oxidizer.

The oxidizer is much easier to handle than elemental F<sub>2</sub> and it does not form HF when exposed to water. Care still must be maintained as there is evidence of some toxicity.

RMD built a pilot plant which can provide up to 2 lbs. of OF<sub>2</sub> per day. Allied Chemical recently completed a facility capable of 20 lbs. per day.

RMD used the classical reaction:  
 $2F_2 + 2NaOH = 2NaF + OF_2 + HOH$   
 —but Allied may have a different process. Current cost of OF<sub>2</sub> is \$70 per lb. but high demand conditions could bring this down to a range of \$3-\$5 per lb.

A cylinder of liquid OF<sub>2</sub> has been subjected to gunfire tests using .22 caliber long rifle bullets at Harshaw Chemical Co. Although the cylinder failed, there was no evidence of propellant shock sensitivity.

The oxidizer will not burn but does

support combustion. Because of its high volatility, RMD suggests an OF<sub>2</sub> fire be allowed to burn if possible. Water flooding seems justified in other cases.

RMD is taking the conservative approach. N<sub>2</sub>O<sub>4</sub>/MMH systems stand high in performance in the earth hypergols and OF<sub>2</sub>/MMH and OF<sub>2</sub>/B<sub>2</sub>H<sub>6</sub> generally bracket the fluorinated oxidizer group. A propulsion system developed for the peroxide can be significantly upgraded in performance through the simple substitution of the fluorinated systems.

At optimum O/F both propellant combinations have nearly the same bulk densities and both oxidizers are compatible with several common tankage materials. RMD will gradually move up through the series and some thought has been given to propellant systems beyond the OF<sub>2</sub>/B<sub>2</sub>H<sub>6</sub> combination.

In each case of substitution there are considerable increases in payload capability; the amount depends on the mission.

Taking 10,000 ft. sec. as a representative minimum velocity increment necessary for lunar orbiting or landing, an increase in overall payload for three main propellant groups has been calculated. The groups are earth-storable hypergols, cryogenics and fluorinated oxidizers.

The earth-storable hypergols can carry approximately 4600 lbs.; the cryogenic systems improve this to 5500 lbs., and fluorinated oxidizers push it to 6300 lbs.—a 33% improvement over the earth-storables.

| Physical Characteristics of OF <sub>2</sub> |                                 |
|---------------------------------------------|---------------------------------|
| Freezing Point                              | —371°F                          |
| Boiling Point                               | —229°F                          |
| Vapor Pressure                              | 0.062 psia —312°F               |
|                                             | 0.209 psia —298°F               |
|                                             | 8.3 psia —240°F                 |
|                                             | 89 psia —180°F                  |
| Critical Temperature                        | —72°F                           |
| Critical Pressure                           | 719 psia                        |
| Density                                     | 108.3 lb/ft <sup>3</sup> —310°F |
|                                             | 95.5 lb/ft <sup>3</sup> —229°F  |
| Viscosity                                   | 0.2826 cp —228°F                |
| Heat of Formation                           | 30.2 Btu/mol (gas)              |

# TIMM's Withstand High Radiation

**GE-developed ceramic units to be used in tiny guidance computer, may prove ideal for nuclear-powered craft**

by Charles D. LaFond

THERMIONIC Integrated Micro Modules (TIMM) may solve many instrumentation problems in nuclear-propelled vehicles.

The tiny ceramic active and passive elements, under development for the past four years at General Electric Co., have continuously shown unusual tolerance for high radiation levels as well as high resistance to shock and vibration.

Called TIMM's, the unique components were first developed in 1958 by the GE Research Laboratory. They are now being tested and produced in limited quantity by the company's Receiving Tube Department in Owensboro, Ky., under an Air Force contract.

First application of the integrated modules will be in a missile/space guidance computer now under development at GE's Ordnance Department in Pittsfield, Mass. The space computer will be

the size of a cigarette box, weigh less than 7 pounds and require only 30 watts, developers say.

Steady-state reactor exposure by electronic subsystems could be a great problem some day. Semiconductors start to degrade or at least change characteristics after radiation exposure beyond  $10^8$  roentgens (integrated gamma rays). In fast neutron flux, tunnel diodes reach noise increase at over  $10^{13}$ NVT, permanent degradation above  $10^{15}$ NVT. Transistors experience damage beyond  $10^{13}$ NVT.

Full test results on GE's TIMM's have not been released yet. However, it is known that the ceramic units have withstood dosages to  $10^{19}$ NVT and  $10^{11}$  roentgens without damage.

• **TIMM circuit elements**—So far a variety of diodes, triodes, resistors, and capacitors have been produced for TIMM modules. Recently, inductors have been devised. All of the components are easily integrated, wafer-thin discs.

For active elements, titanium has been found to be an excellent gettering material at about  $600^\circ\text{C}$ . Thus, continuous gettering is obtainable during operation within "tube" vacuums. Actually, the technique applies to all com-

ponents since titanium electrodes are used throughout.

The cathodes are of conventional oxide type on a platinum base. It was found that this metal, which is chemically passive, reduces evaporation rate at high temperatures by one-thousand fold, compared to conventional nickel-base cathodes.

The tube components are assembled according to refined high-vacuum, high-temperature techniques and sealed with nickel-titanium eutectic. Robert E. Bell, one of the developers of the thermionic ceramic devices, told M/R that a typical TIMM triode (with a titanium grid) has an effective built-in grid bias of 2.3 volts—eliminating the requirement for a bias circuit and, of course, assisting in simplification of related circuits.

TIMM resistors utilize resistive deposits on the surface of ceramic discs which in turn are vacuum-sealed between electrodes. Resistances vary from a few ohms to a half megohm at power ratings to 1 watt, Bell said.

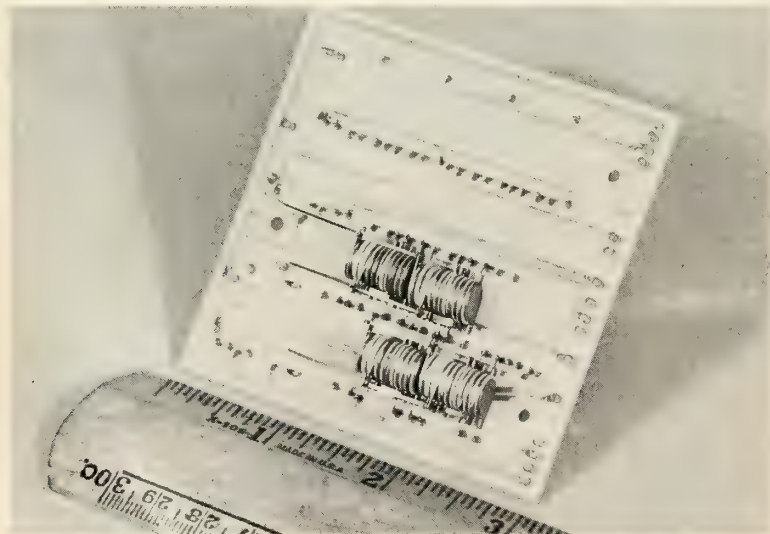
Two types of capacitors are employed. One, for small capacitances, employs alternate stacked layers of conductors and dielectrics. For larger capacitances, units are fabricated by rolling metal electrodes with a dielectric material. The rolled unit is evacuated and sealed hermetically in a ceramic tube. Capacitors range in value from 5 to 800 micromicrofarads.

GE has not made available any details of its TIMM inductor development except to state that units are available with inductances varying from 2 to 30 microhenries.

• **Early studies** — The development by GE's Research Laboratory of practical TIMM's circuits was first formally announced by the company in Philadelphia in the spring of 1959. (M/R, May 25, 1959, p. 29).

At that time several "operating circuits" were demonstrated to indicate the potential of such electronics fabrication. One was a circuit function capable of 10-mc operation which included a pair of triple-input "AND" gates, a bistable multivibrator, and dual cathode follower outputs. In all, the pencil eraser-size assembly contained 30 parts, representing a parts density of about 250,000 components/cu. ft.

Power requirement was 0.75 watt



*TIMM MODULES are stacked and mounted on these insulated boards. Module (stack) interconnections are welded to conductor runs bonded to boards. All power inputs and grounds are through ribbon connectors on top sides of modules.*



and the self-generated ambient operating temperature was 580°C.

The significance of this demonstration model was in its comparison with an equivalent semiconductor circuit. Using even the best known assembly techniques at the time, the equivalent conventional circuit attained a parts density of only 33,000/cu. ft. and was limited in operation to a temperature range from -55° to 71°C.

TIMM circuits offered a built-in answer to the heat problems which were steadily mounting in military systems because of requirements for tighter packaging of components. They thrived on heat and were stabilized by surrounding the circuits with thermal insulation. No heat transfer was needed or even desired.

Furthermore, because the active element in such circuits involved a thermionic device, the need for cathode heaters was obviated. This simplified the circuitry and, consequently, increased reliability.

In addition, the all-ceramic/metal construction made the devices rugged and gave them unusually high resistance to shock and vibration.

Finally, extensive tests had shown such units to be highly resistant to nuclear irradiation damage. In fact, studies had demonstrated that the circuits were at least 1000 times less susceptible to radiation degradation than conventional circuits.

Why, then, with all these characteristics so desirable for missile space electronics systems, have TIMM's not been widely used?

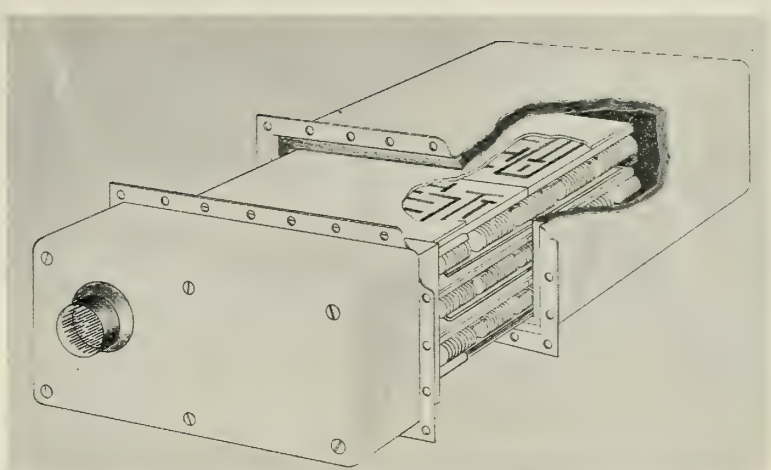
Some GE enthusiasts feel that the concept may have been the victim of a rapidly changing technology. Micro-miniaturization per se is being researched from every conceivable angle by just about every electronics manufacturer—for a host of government agencies and for their own competitive betterment.

Development funding from the outside has been negligible for TIMM's. GE has continued development, particularly in circuit applications, but company support has likewise been austere.

It is also very possible that the 1959 release of data on prototypes was premature. In any event, however, TIMM's proponents feel they have a unique and a significant product.

To prove its worth, GE engineers have been developing a highly advanced TIMM computer for missile/space use. Concurrent with development of all the necessary working modules for such a system, environmental testing of components has been accelerated.

• **Circuit development**—Once the concept of TIMM was firm and com-



*DRAWING OF TIMM computer now being developed by Ordnance Dept. of General Electric Co. The seven-lb., 100-cu.-in. package will require only 30 watts of power and will operate in its thermally insulated case at over 580°C.*

ponent fabrication problems were solved, the next step was proving feasibility of practical circuit applications.

As many have done in the micro-miniaturization field, GE engineers investigated computer applications. Starting with basic TIMM diodes and triodes, researchers looked into NOR, flip-flop, clock, and temperature controller circuits. Delay-line drivers and receivers also were studied.

It was felt that these circuits presupposed development of a computer using NOR circuitry as basic logic elements and either delay lines or disc storage. Emphasis was placed on the NOR circuit.

The NOR circuit was designed to take advantage of the built-in bias characteristics of TIMM triodes and diodes. Also, its design made use of a direct coupling and other features developed by several GE divisions.

For short-term storage or one-bit delays, a bistable flip-flop was built. A synchronous circuit, it was constructed of two basic NOR circuits, ring connected with triode AND circuits for gating and synchronizing.

The computer clock is a two-stage amplifier with a positive feedback circuit composed of the frequency determining element—a quartz crystal series resonant at 200 kc.

The amplifier and crystal comprise the oscillator circuit. Again, the NOR circuit configuration was used where practical.

Delay line receiving circuits used with piezoelectric delay lines consist of an amplifier section, similar to that used for the clock circuits, plus a NOR or flip-flop output stage.

Accurate temperature control of TIMM circuits apparently offers no serious problem. A very simple circuit

was devised; it uses the TIMM diode emission characteristics to control power to "vernier" heating coils.

Two basic storage approaches have been suggested for use with the TIMM computer. The first is a Bernoulli disc (built by Laboratory for Electronics) that uses magnetic tracks for storage. Capacity is 60,000 bits on a 4-in.-dia. disc.

Sonic delay lines studied employ two types of driving transducers: the first operates on a magnetostrictive principle; the second makes use of piezoelectric properties of materials, such as barium titanate, lead zirconate titanate, quartz or lead metaniobate.

After a series of tests, delay-line storage was adjudged the most acceptable.

• **Computer progress**—The proposed computer will be a 7-lb., 100-cu.-in., digital differential analyzer. A NOR circuit was selected as the basic building block, since almost all the logic circuits can be created by using it and TIMM enables simplified construction.

The finished package will contain 324 equivalent NOR circuits. It will use serial word storage provided by sonic wire delay lines. Power required will be roughly 30 watts, largely unregulated.

The basic NOR module is 0.301 in. high by 0.325 in. in diameter. Connections between adjacent elements generally are formed in the stacking arrangement. Circuit module interconnections, except for supply and ground, are made through tabs welded to conductor runs bonded to each side of ceramic mounting boards.

Completion of this first TIMM computer is expected next year. But extensive radiation tests, now being conducted by the company, may decide the future of such systems. ♦♦

# Space Lubricant Research Pushed

by Michael Getler

IF THE NEXT generation of U.S. satellites is to operate in space for 3-5 years, as planned, major breakthroughs in component reliability are essential.

High on the list is development of new lubricants and application techniques for precision bearings and slip-ring assemblies.

This is the problem: Most spacecraft now in operation or scheduled to orbit by 1964 are designed for one year of operational life. Processes already available can keep lubricated parts working for this period.

But the programed deep space probes to Mars and beyond—and advanced communication, observation, and weather nets planned for extended time in orbit—will demand lubricants which can greatly extend bearing service life and function in new environmental extremes.

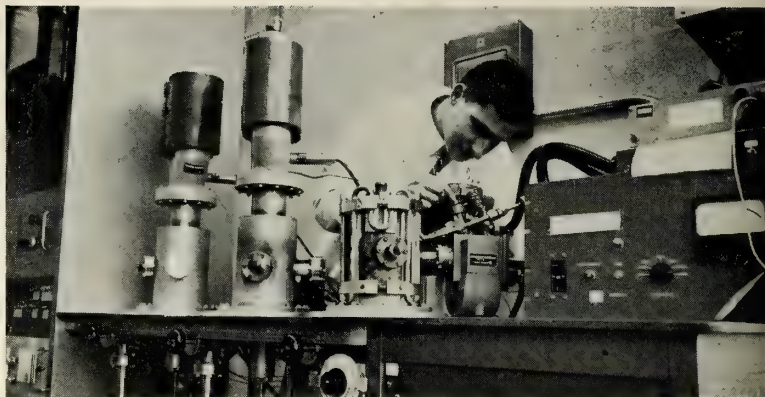
The National Aeronautics and Space Administration is beginning to push forward in this area, and industry is beginning to stir.

Working under two separate NASA contracts, CBS Laboratories of Stamford, Conn., last week disclosed its early findings in the development of a new vapor-deposited dry-film lubricant. The company announcement was made at a CBS-sponsored symposium on friction problems in space, attended by some 70 representatives of the bearing and gear industry, the aerospace industry, NASA, and the Air Force.

• **CLD-5940**—CBS, a new contestant in the field, claims that its new CLD-5940 lubricant process, when applied to precision bearings and tested under high-vacuum simulated space environments, increased operational life of the parts by a factor of ten.

Alfred F. Kaspaul, co-developer of the process with Erika Fliege, described experiments in which bearings coated with CLD-5940 were operated for 3000 hours at atmospheric pressures approaching  $10^{-9}$  mm of Hg. Conventional coatings of electroplated silver-molybdenum disulphide reportedly broke down after about 280 hrs. Low frictional coefficient figures were also reported during tests of bearing life in air under pressures of about 400,000 psi.

Described as multi-layer coatings of less than one-half-micron thickness, the new dry-film lubricant has three other



IN CHAMBERS operated at pressures below  $10^6$  mm Hg., slip ring assemblies processed with dry-film lubricants are tested for noise, contact resistance, torque.

major advantages, according to Kaspaul:

- Airborne relubrication.
- Maximum thermal conductivity along the load-bearing surface.
- Electrical conductivity.

Maximum adhesion, Kaspaul explained, is obtained through the molecular bonding of the initial thin-film layers to the substrate surface. Vapor deposition of these coatings assures maximum purity of lubricant coatings and controls film thickness. The half-micron film thickness does not interfere with tolerances of fine precision bearings and minimizes the plastic deformation of the lubricant which takes place under load, he continued.

• **Slip-Ring Tests**—Dr. Stanley Cosgrove, manager of dry-film lubricant R&D, reported that performance tests were made on dry-film lubricated slip rings at various temperatures and for periods of more than 300 hrs. at pressures of  $10^{-7}$  mm of Hg. Results according to Dr. Cosgrove, indicated significant extensions—some by as much as 100 times—in the useful life of conventional slip rings operating in high-vacuum environment. No adverse effects upon torque, contact resistance, or electrical noise were reported.

CBS is currently developing a prototype vacuum slip-ring assembly for NASA's advanced meteorological satellite, *Nimbus*.

The feasibility of reapplying the dry-film lubricant coating in high vacuum has also been tested on prototype slip rings at reduced atmospheric pressures of  $10^{-7}$  mm of Hg.

First major deployment of the CBS process is likely to be aboard NASA's *Orbiting Astronomical Observatory* (M/R, Dec. 4, p. 16). Grumman Aircraft and Engineering Corp. of Bethpage, L.I., N.Y., prime contractor, is reportedly pleased with test results.

The new CLD-5940 may be used to lubricate bearings on the satellite's sunshade, a device to protect the optical equipment carried aboard *OAO* from solar energy.

CBS entry into the development of special solid lubricants was prompted by requirements for a line scan tube used in the company's *Photoscan* aerial reconnaissance and surveillance system (M/R, Feb. 15, 1960, p. 18). In this special tube, a phosphor-coated metal drum anode is rotated at 1600 rpm within the high-vacuum envelope.

Bearing requirements within the line scan tube closely approached those demanded in space vehicles: bearing life in excess of 2500 hrs, low starting and running torque, wide operational temperature range, negligible gas release during prolonged operation, electrical conductivity, and sufficient shock and vibration stability to withstand severe acceleration forces.

During the search for lubricants which could guarantee these system requirements, CBS reported that conventional oils and greases evaporated rapidly under high-vacuum conditions, and that commercially available dry lubricants tested proved erratic and exhibited relatively short life and high frictional coefficients. ■



# Monsanto High Heat Resins for space age applications

Monsanto Resinox high heat resistant resins were developed to withstand elevated temperature exposures. Now being used in missile and rocket components, laminates made with Resinox Resins have high strength-to-weight ratio, low rate of ablation, excellent shock resistance, low thermal conductivity, and stability at extreme temperatures.

## Monsanto High Heat Resins include:

**Resinox SC-1008—Phenolic Laminating Varnish.** Designed for applications requiring extended exposure at temperatures to 500°F and very short term exposure in the 5000°F temperature range. Offers good ablation resistance.

**Resinox SC-1013—Silane Modified Phenolic Varnish.** For applications demanding extended exposure in the 500°F to 600°F range, and very short term exposure above 5000°F. Offers superior high frequency electrical properties.

**Resinox TS-5946—Elastomer Modified Phenolic Varnish.** Recommended for blending with high temperature phenolic resins to increase tack for

ease of layup, and increase flexibility and resilience of final laminate.

**Resinox RI-4080—Modified Phenolic Resin Compound.** Modified phenolic resin designed for use in moldings which must have short-term heat resistance to temperatures of 2000°F or higher.

**Resinox RI-4009—Phenolic Resin Compound.** Developed for use with glass and asbestos filter materials. It can be used in dry powdered form or as a varnish when dissolved in alcohol. For more information, write for a copy of "High Temperature Resistant Resins Folder" to Monsanto Chemical Company, Plastics Division, Room 828, Springfield 2, Massachusetts.



Resinox Reg. U. S. Pat. Off.

FOR EXTENDED EXPOSURE 600°F TO 700°F ... SHORT EXPOSURE OVER 5000°F

# Test Renewal To Spur Tonopah Growth



**TARGET** for hard-target drops at Tonopah Range is made of foot-thick concrete. Each bar of the "X" is 550 feet long.

by Frank G. McGuire

RESUMPTION of nuclear tests in the atmosphere by the United States would accelerate the current expansion of the Atomic Energy Commission's Tonopah Test Range (TTR) in Nevada.

The range, operated by Sandia Corp. for the AEC, is scheduled to get new control buildings, an airstrip and instrumentation for support of rocket launchings and aerial drops of nuclear weapons.

Although no nuclear detonations take place on the range, Sandia fires rockets to altitudes of 500,000 feet and tests prototype weapons against hardened targets in a concerted effort to improve U.S. nuclear capabilities.

Completion of the latest phase of expansion at TTR is due by early 1962, and is expected to relieve presently crowded conditions in the existing facilities.

The range, measuring approximately 24 by 26 miles, is 140 miles northwest of Las Vegas and is adjacent to the Las Vegas bombing and gunnery range. Located on Cactus Flat, it is made available on a non-interference basis to other government agencies and their contractors.

Concrete and masonry buildings will be added for additional administration space, and a frame building will be constructed to serve as a control room for

the range. The present headquarters and control building contains Sandia's offices and control consoles for aerial drops and rocket launchings. It also houses photo dark rooms, electronics work rooms and a camera repair shop.

• **Warhead tracking**—The new airstrip is for chartered aircraft carrying personnel and freight, according to Sandia, and will be used by light aircraft for the most part. The presently-used airstrip is 11 miles from the headquarters building and the newer strip is expected to cut down the ground travel time and contribute to range safety.

The test range is comprised of 50 instrument stations, and during operations periods is manned by some 50 personnel. Sandia describes the range as three-in-one, with a range to ballistically track nuclear shapes released from aircraft, another range to handle high-altitude drops and a third range for rocket vehicle work.

By making prior arrangements with the gunnery range, flights in excess of 100 miles can be made in connection with a program.

In the primary target area, the instrumentation consists mainly of fixed cameras providing ballistic coverage for test vehicle release missions. Further back from this target area and along the flight line are tracking photo-theodolites, tracking telescopes, radar, and other radio-frequency tracking systems



**STATION FOUR** includes 15-ft. domed tower housing Askania Theodolite, ground-level dome with Sandia ME-16 telescope.

providing ballistic coverage for medium- and high-altitude releases from aircraft.

These same instruments are also used to provide ballistic coverage in support of rocket launchings. It is these instruments, in conjunction with the main rocket complex, that comprise TTR's third range.

• **Rockets in hundreds**—A number of complete FM/FM telemetry recording systems are available for use on all ranges.

Utilization of the range is usually for hard target tests in the morning, high altitude drops during mid-day, and rocket firings later in the afternoon.

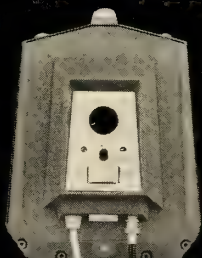
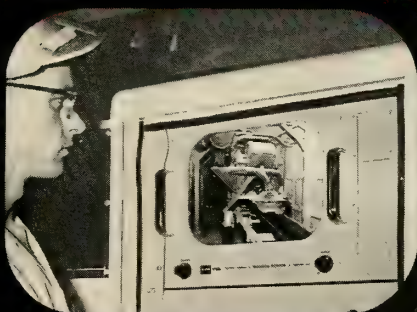
The 50-man range crew handles the stations for hard-target coverage, then switches to the other stations for coverage of high altitude and rocket tests. Some stations, however, are used for all three types of activity and are thus in use throughout the operational cycle.

Up to four tests a day are conducted at TTR, which operates five days a week. Several hundred rockets have been fired since the range began operation in February, 1957.

Rocket vehicles and missions include a Mach 5 test vehicle, a chaff rocket to check wind velocities at altitudes of 100,000 to 300,000 feet, and a supersonic parachute test vehicle. The last of these is to check the performance of parachutes and other drag devices at speeds of Mach 2 at low altitudes. \*



new! low-cost  
self-contained  
TV camera  
provides 650 line  
resolution!



Control panel  
detaches from camera  
for remote operation  
via stock cable

High-quality closed circuit television is now more practical than ever. KIN TEL's new 20/20 camera is the reason. It contains its own control circuits. This eliminates the separate unit so long traditional with high-quality TV systems...lets you connect the camera directly to a monitor—or home TV receiver.

**The 20/20 is easier and less expensive** to install, operate, service. Yet it gives the sharpest, clearest pictures in the industry—650 lines of horizontal resolution. It is so sensitive that you can get usable pictures with as little as one foot candle of illumination—less than the light now falling on this page.

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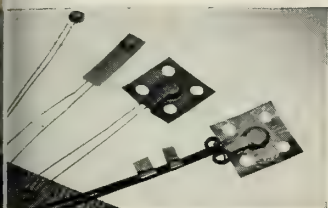
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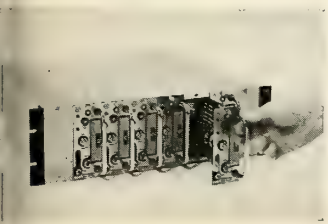
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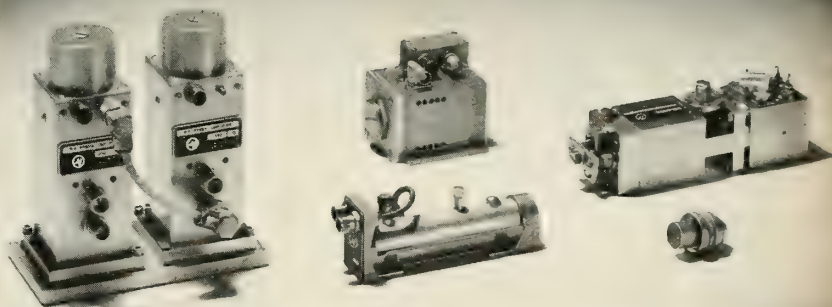
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For more information, write for these illustrated, detailed bulletins: Bulletin PTM-1, JSC-1, and ATC-1.



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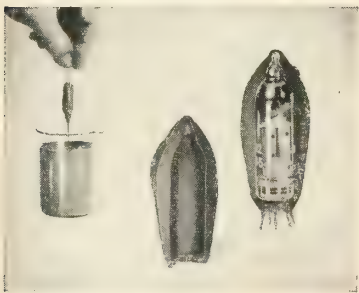
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# General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the "thermal toughness" to stand up under the searing heat of rocket blast-off or possible atomic attack. Add very good electrical properties and excellent resistance to aging, weathering, moisture, flame, ozone and corona and you can easily see why silicone rubber is now being used in virtually every U.S. missile and space vehicle.

Since both space technology and silicone rubber are relatively new, General Electric believes there are many more areas not yet explored where silicone rubbers can help keep a missile functionally reliable and combat-ready. To help designers in their evaluation work, we list here the principal properties and applications of G-E silicone rubber.



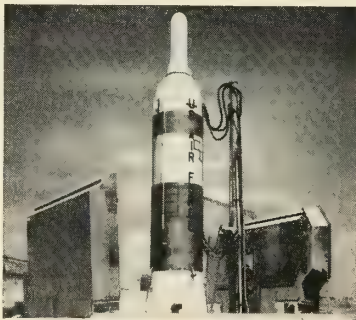
**RTV LIQUID SILICONE RUBBER** — One of the most versatile materials developed in recent years, RTV is a liquid rubber that cures at room temperatures. Like all silicone rubber, it remains flexible over a wide temperature range and is virtually ageless. Since it comes in a wide range of viscosities, it can be poured, sprayed, dipped, painted or applied with a pressure gun or spatula. It bonds tightly to metal when a primer is used. When not primed, you can readily remove RTV and then reapply more. You can impregnate tightly wound coils with RTV or form sections several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

|                       |                                                                                         |
|-----------------------|-----------------------------------------------------------------------------------------|
| Viscosity             | from 120 poises<br>(very pourable) to<br>12,000 poises (paste)                          |
| Specific Gravity      | 1.2 to 1.5                                                                              |
| Solids Content        | 100%                                                                                    |
| Shrinkage             | 0.2%                                                                                    |
| Heat Resistance       | from —90°F to<br>600°F, and as<br>thermal insulation,<br>in 5500°F flame<br>for minutes |
| Ozone Resistance      | Comparable to Mica                                                                      |
| Electrical Properties | See last table                                                                          |

**Applications**—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.



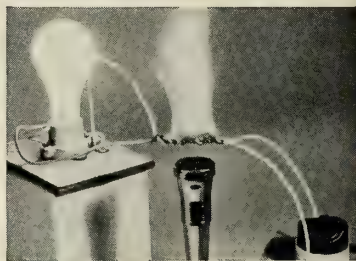
## HEAT CURED SILICONE RUBBER PARTS

—Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and non-aging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

|                       |          |
|-----------------------|----------|
| Tensile Strength, psi | 800—1500 |
| Elongation, %         | 100—600  |

|                                 |                               |
|---------------------------------|-------------------------------|
| Hardness Durometer<br>(Shore A) | 25—80                         |
| Compression Set, %              | 10—80                         |
| Tear Resistance lb/in           | 40—200                        |
| Radiation Resistance            | 1 x 10 <sup>8</sup> roentgens |
| Electrical Properties           | See table below               |



**WIRE AND CABLE INSULATION** — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

|                                |                                    |
|--------------------------------|------------------------------------|
| Volume Resistivity             | 10 <sup>15</sup> —10 <sup>16</sup> |
| Dielectric Strength, volts/mil | 600—650                            |
| Dielectric Constant, 60 cps    | 3.0                                |
| Power Factor                   | .0010—.0050                        |
| Radiation Resistance           | 1 x 10 <sup>8</sup> roentgens      |
| Physical properties            | Similar to table above.            |

**Applications**—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section 01233, **Silicone Products Department, General Electric Company, Waterford, New York.**

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# Titan II Sites Nuclear Shock-Proofed

by James Trainor

**SURVIVABILITY**—not dollar savings—is the goal of a comprehensive component test program being conducted on systems for *Titan II* ICBM launch sites.

Using a specially designed, low-shock zone machine, the environmental test program is seeking to insure that every device installed at the underground sites is capable of sustaining the shock and vibration from a thermonuclear explosion.

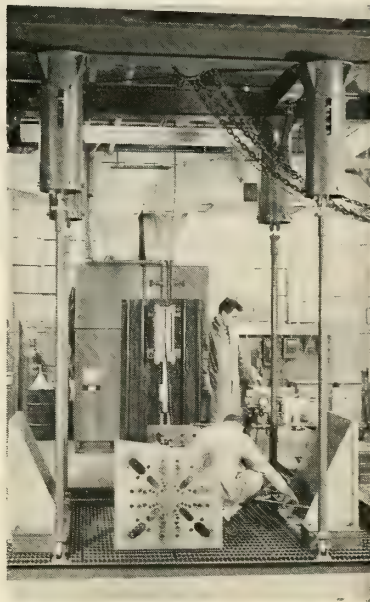
To simulate the effects of a nuclear blast, the Environmental Testing Laboratories of Belock Instrument Corporation have built, and are now operating for the government, a 3-g shock tester which duplicates the expected post-attack forces experienced by components within a *Titan II* site. The machine was built from specifications furnished by the Corps of Engineers Ballistic Missile Construction Office.

• **Shock environment defined**—Although the shock zones for *Titan II* sites range from  $\frac{1}{2}$  g to as high as 3000 g, components within the control center and the launch complex are expected to experience only a 3-g force. This reduction of the shock force is due primarily to the suspension system within the complex. Components are mounted on platforms which, in turn, are suspended from massive overhead springs.

When the shock from a nuclear blast reaches the *Titan* site, it causes an earth movement of approximately 3.58 in. down and away from the direction of the blast. It is this earth movement which causes the 3-g force on the internal platform-mounted components and test and checkout systems.

To duplicate these conditions, the special-purpose environmental test machine was built by Belock. Essentially, the tester is a scaled-down section of a silo platform on which the components will be mounted. The overhead suspension system within the silo has also been duplicated to the same scale.

Components to be tested are mounted on the machine's platform in the same position that they would be in the actual silo. The platform is then hydraulically displaced exactly six inches downward until it is brought to rest by



*SPECIAL Belock machine is used to test shock resistance of Titan site components.*

a stop block on the hydraulic arm. At the same time, the hydraulic system pulls the platform to the rear 3.5 in.

The action of the hydraulic displacement compresses the overhead springs which, when a shear pin on the hydraulic arm fails, attempt to restore the platform to its normal position. This spring force, consequently, causes an additional six inches travel above the normal.

After the shear pin failure, the entire platform is subjected to the 3-g shock, analogous to the expected nuclear environment. The free platform is allowed to oscillate freely until, after approximately 20-30 seconds, it finally comes to rest.

• **Component operation tested**—During the shock and vibration test, each component must be in its normal operating, or active, state. In addition, some components are tested both in their energized and de-energized states. For example, valves which are normally open may be tested first in their open position and then in their closed mode. During all of the tests, the equipment is

monitored for indications of failure.

Following the shock test, the component is given an exhaustive check to determine any faults that may have developed which are not readily apparent. For example, water tanks are filled with water and hydrostatically tested to determine leaks. The welds along the support legs of the tank are checked for faults. And, finally, the gages on the tank are checked for normal operation and accuracy. Control devices are monitored by a recording oscilloscope with power applied; transformers are energized and run for 2-4 hours after the test to determine any arc-over; and valves and pressure switches are operated in all positions.

In describing the test procedures, Belock engineers point out the importance of exactly simulating the 3-g environment. Too much shock, they stress, would result in an unfair evaluation of a manufacturer's piece of equipment while too little would be detrimental to the government's interest.

For this reason, before each test the platform is weighted so that the mass seen by the springs remains the same. If this dead weight were not added, light components would experience a greater shock than their heavier counterparts. Again, this would be unfair to some of the equipment manufacturers.

A unique feature of the *Titan II* suspension system, Belock engineers point out, is the spring system. Whether the platform is moving up or down, the springs are constructed so that they are always in compression. This results in cheaper and fewer springs. Normal springs, they say, would be larger, longer and more numerous.

• **Extensive test program**—Virtually every component installed in the *Titan II* sites will have to undergo the low-shock zone test before it is accepted by the Corps of Engineers. Belock, who conducted approximately 40% of the shock tests for *Titan I*, expects to do approximately the same percentage of *Titan II* testing. Wiley Laboratories in California and individual manufacturers will account for the remaining 60% of the testing. The test program—begun last week—is expected to continue for the next year and a half. ■

## Space Medicine—Daddario

(Continued from page 16)

in discussing this problem. The priority which President Kennedy has set on the moon shots affords the opportunity to prove that the nation is ready to go ahead, adequately funded, for a specific program of biomedical research in space conquest. What we need to know is that we have selected the best avenue of approach to our objective and that we have established a means to coordinate and validate requirements.

Where necessary, we may have to shift responsibility from time to time for the use of existing facilities so that they can make their maximum contribution. And we must be prepared to monitor research so that we are informed on our progress.

One of our fundamental needs is an adequate inventory of the resources available for such research. The National Science Foundation has the authority and responsibility to conduct such a survey and I hope it will make it a priority matter.

I am disturbed by the narrow base of skilled manpower experienced in the biomedical area, because I believe it encourages a black market in the enlistment of such talent so long as we do not have clearly defined goals and priorities. The rapid onrush of life sciences research encourages piracy among personnel. We need a responsible and orderly program.

### • Space Council responsibility—

How can we go about it? I think that authority exists at the Space Council level to work out programs for the determination of future research goals. Whether the White House, through its Science Adviser, would exercise prerogatives to determine or review and validate such goals, I don't know, but I do know that the Space Council itself has a Congressional mandate to work out approaches to the solution of problems in the space field so that wasteful duplication is avoided.

Only if we take a national approach to our needs in biomedical research can we identify, for instance, programs which may have a high national priority, but a low agency priority. Given the factors of a limited number of skilled bioscientists and a manifold number of programs that are desirable in the national interest, it is imperative that a unified program be established.

• **Duplication**—The program to date has raised serious questions of duplication of effort. In looking over the titles of research projects sponsored by the Air Force and by NASA, examples such as weightlessness studies

or the effect of radiation leap to the eye.

What part of these studies are duplicative and what parts may be needed to secure the correct solution cannot be told by the titles. But even the most cursory examination leads to the conclusion that little thought has been given to selective research that would avoid duplication to the maximum extent.

The coordinating committees so frequently cited in self-defense cannot, by the factor of time alone, have had a chance to review in detail the programs which have multiplied. A proposal for a vivarium to support certain NASA research was dropped after pointed questions were asked; issues regarding the new manned space flight center and its role in relation to current and planned defense research have just not been answered.

NASA needs a continuing sense of the importance of full utilization of national resources and of its responsibility to the people of this country if it is to make progress in the most effective sense. Some steps in the early days of the development of NASA's life sciences program make it look as if planning had taken effect in a vacuum.

If the American people are to subscribe fully to the organization of the moon effort and are to lend their own sense of urgency to this drive, they must be assured that decisions are made after full consideration of the size and scope of the planned project and the alternatives that exist.

• **Goals are high**—But organization and management are, of course, related to the goals we seek. And the goals we seek have magic to stir the blood as we stand astride the twentieth century and look to the future.

The question of life itself—what originates it, what prolongs it—may well be the most fascinating challenge man has to solve. Despite decades of intensive research, laboratories have not yet resolved questions regarding the conversion of light into chemical energy. As man learns more about himself, as he is able to project himself into greater extremes of speed and temperature and activity, he may find the key to unlock a great storehouse of knowledge.

The knowledge we secure from the necessary tests and experiments can do much to prolong life and ease our lot on earth. The medical benefits of the *Mercury* program thus far have been warmly welcomed by the medical profession.

• **The financial burden**—But the financial resources with which we have to push this program are not unlimited.

Our highest priority is on defense and the national security. This takes more than 55% of our budget. The other programs, including those of the greatest importance to our future well-being, must use the money granted them wisely. It is not wise to strike out for useful goals without measuring the distance or comparing the avenues to reach them and the help that is available.

Our first move into the life sciences field as it affected space was dictated by the mission and the readily recognizable goals. It failed to take full account of the work that had been done and the resources already in existence.

Since that time, the need to coordinate our resources and our research has been emphasized and progress has been made. But we are working in a tremendously complex field, where interdisciplinary effort is required to secure the information, to digest it and to use it.

This is not a simple problem. It requires the utmost in managerial skill to design and make effective a program to use all the resources of this magnificent country—civil and military, private and public—towards the attainment of a national goal.

It is easier to identify specific areas where progress can be made, such as medical instrumentation, and work independently towards new advances. But unless we take the measure of the full task, unless we establish how best we are to determine our goals and how best to reach them, then we will waste two most precious commodities—time and effort—in a field in which a decade may show that we could not afford them. ✱

## Space Medicine—Goal

(Continued from page 17)

marked muscle atrophy in the absence of gravity. This not only is important to the astronaut while he is in space, but is extremely undesirable when considering his reaction to the positive accelerative forces he must experience on re-entry.

Until we have more knowledge regarding his reaction to the weightless state, we cannot tell whether or not he will need an artificial gravity. There has been recent mention of so-called "space sickness" suffered by the cosmonaut Titov during his 25-hour orbital flight. Recent conversations with Soviet scientists have indicated this consisted of three brief intervals of vertigo during the trip. This is not particularly surprising when considering our knowledge of motion sickness and its occurrence when the three semicircular canals in the inner ear are stimulated simultaneously, as





## No two are the same

And the molecules in any two elements are never the same either. At Cal Tech's Jet Propulsion Laboratory, these molecular differences will soon add up to a better understanding of what the Moon is made of.

When the first Surveyor spacecraft soft-lands on the Moon in 1963, it will drill into and extract samples from the Moon's surface. After an electric oven decomposes these samples, their molecules in the form of burned-off gas will pass through a column to a detector. The detector response rate—and the amount of molecules—will be recorded and transmitted to earth.

Since JPL scientists and engineers know what mole-

cules cause what kinds of responses (fingerprints), they will then know what elements are on the Moon. Most important, they may detect pre-life molecules on our satellite—a first clue to life in outer space.

At JPL it takes many good, curious, searching, dedicated minds to determine what instruments will measure what on the Moon and planets. Many many minds that work as one. Minds such as yours, perhaps. Will you write us today? If you have a mind to?

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they would be during such a flight.

The only way for us to find out if man can tolerate increasing periods of time at zero gravity is for him to be there. If, in spite of the many preventive measures such as physical conditioning and perhaps drugs, he still cannot tolerate the absence of gravity, then we must create the gravity field by rotation of the capsule itself.

In this event, we will further need to establish the minimum amount of gravity the human can tolerate for prolonged periods without suffering any distracting symptoms.

The radiation that occurs in space is the phenomenon about which the least is known. We know radiation of various types produces cellular damage to the person exposed. In other instances, it may cause gonadal effects which will increase the person's chances of producing abnormal offspring one or several generations hence. Natural radiation intensity in space varies with position and time.

First, there is primary cosmic radiation in the inner and outer Van Allen belts. The inner belt has the greatest intensity of radiation. At an altitude of about 2000 miles, the intensity is about 12R per hour even when protected by a shield weight of 25 lb. per sq. feet. For comparative purposes, 25R has been recommended as an emergency, one-in-a-lifetime dose. This is the joint AEC recommendation, although there has never been evidence of a single pathologic change demonstrated in a human subjected to 25R. 400R represents LD 50, meaning that at least 50% will die on exposure to this radiation, even with some shielding.

These Van Allen belts, however, are well described and may be avoided or passed through rapidly. Solar flares are far more serious radiation hazards. They occur at a frequency of about 5 to 10 per year, apparently in bunches. There is thus no way of avoiding the hazard by starting a space flight just after a solar flare.

These flares seem to occur in about 11-year cycles. We are now approaching a solar minimum, which means that we will be working up to a maximum into the late 1960's. This is, of course, extremely unfortunate with the timing of our present lunar expeditions.

It is obvious that, to keep our prime prerequisite of safety for the human fulfilled, we must learn more about the existence of radiation and types of radiation present with or without solar flare activity. We must, therefore, definitively measure animal's cells reaction to this radiation before we expose humans; and, finally, we must determine exactly the degree of protection necessary so that biological changes will not occur.

Finally, the psychologic reaction can only be ascertained by exposure of the subject to space. Regrettably, no matter how hard we try, the human subject of an altitude chamber test knows there are six pairs of eyes watching him from the outside at all times, and that, if he gets in trouble, help is immediately available.

Our program here must be one in which the results of the next flight are based on the last. If the astronaut does not react adversely to 12 hours of flight, then he is perhaps ready for 18 or 24 hours. It will at no time be scientifically sound to fire him for two weeks if the longest previous experience has only been one day.

• **Extra dividends**—In the completion of a lunar mission, with all the inherent difficulties described above that must be solved before the launch, we will obtain dividends not only of a political nature but certainly of scientific value.

As we evaluate a cell's response to radiation, for example, we will also be learning more about the cell itself. As we increase our knowledge of that cell, we will also be increasing our knowledge as to why that cell might suddenly rapidly reproduce large numbers of non-functioning cells, known as cancer.

As we take the precaution of being sure the three astronauts on Project Apollo will not come down with a disease process after launch, we will be learning more about disease processes and their effect on the human body. We may well get definite insight into the early changes seen in many diseases and subsequently improve our understanding regarding how to prevent these diseases.

The job before us in bioastronautics is immense, but fallout from its success will be of benefit to all of mankind in aspects of health and welfare. It will take time, money and dedication, but the goals of the program more than justify their cost. **✱**

## Falloff in Engineer Students Gets Worse

THE NUMBER of freshmen entering engineering schools has dropped for the fourth consecutive year despite prophecies of a vastly increased need.

Based on a survey of 186 U.S. engineering schools, representing 89% of the freshman engineering class, first-year enrollment in engineering decreased 2.3% in 1961.

This is said to be significant because only 37,800 engineers were graduated in 1960. A decade earlier, the nation graduated 52,700.

The Engineering Manpower Commission of the Engineers Joint Council expects a skid to 32,000 by 1965. **✱**

missiles and rockets, December 11, 1961





**Said J. Stefan and L. Boltzmann:** *"The total radiation from a black body is proportional to the fourth power of the absolute temperature of the black body."*

Radiation is usually associated with high temperatures. Yet very cold bodies emit a radiation which can be highly significant in missile and space applications. The problem faced by infrared scientists, trying to detect variations in radiation from low temperature atmospheres, can be likened to detecting a one-foot cube of ice from a distance of five miles.

Lockheed Missiles & Space Company scientists are deeply engaged in studying the problems of infrared emission from the earth and its atmosphere, as seen from orbital altitudes. Although the earth resembles a black body at 300° Kelvin, the emission from its atmosphere, under some circumstances, is much colder. To make measurements under these circumstances, Lockheed has evolved radiometric equipment with one of the most sensitive detection systems yet conceived.

Scientists and engineers must also take careful measurements of a potential employer. Lockheed Missiles & Space Company in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, invites this close scrutiny. As Systems Manager for the DISCOVERER and MIDAS satellites and the POLARIS FBM, Lockheed preeminence in Missiles and Space creates positions in many disciplines for outstanding engineers and scientists.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-13F, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required. An Equal Opportunity Employer.

## **LOCKHEED MISSILES & SPACE COMPANY**

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# Logistician Is Vital in Early R&D

ORLANDO, FLA.—A convincing plea for including the logistics engineer in the early R&D phases of spacecraft development—as the key to successful manned spaceflight—was delivered at the National Aerospace Support and Operations meeting here last week.

"The logistician, designer and reliability engineer working as a team must provide a means of circumventing . . . potential failures of equipment vital to life support and mission success," three North American Aviation, Inc., engineers told the gathering, sponsored by the Institute of Aerospace Sciences.

The engineers—Dr. D. Amorelli, R. F. Wadsworth and G. O. Moseley, Jr.—cited the trade-offs between the various parameters of any given space mission to support their argument. They also discussed the packaging, handling, transportation, sterilization, vehicle design and communications pertinent to space resupply missions—and proposed one type of unmanned resupply vehicle for space operations.

• **Launch concepts**—Although two portions of the meeting were classified, the remaining six sessions covered the spectrum of space support and operations from launch to space mechanics and space operations development.

One paper attracting interest was "Operational Requirements for Large Space Vehicles," by Jennings Simmons of Douglas Aircraft Co., Inc. Discussing the launch facility requirements to fulfill space missions over the next 10 years, Simmons compared the cost and adequacy of the "fixed" vs. the "mobile" launch concepts.

From his analysis, he concluded that, from the standpoint of cost, the use of decentralized production facilities, water transportation, automatic checkout equipment and the mobile launch concept would be most effective. In addition, he strongly endorsed the development of a workable booster recovery system and a fast method of transportation for vehicle stages from the production facilities to the launch area.

• **Die all at once?**—Emergency provisions for space missions should be planned so that the crew members would not become ineffective or die from starvation, thirst and lack of air at approximately the same time.

Two North American Aviation life sciences engineers pointed out that man could tolerate a certain amount of starvation and dehydration, but not a lack of oxygen. Therefore, the oxygen supply should far exceed the amount of food and water, so that he might continue to live in an emergency situation wherein he was cut off from a new source of supply or return to ground.

For instance, the engineers point out that a mission planned for 5 days with normal quantities of food and water could be extended to 14 days if these supplies were replaced by oxygen and lithium hydroxide. Or a 14-day mission could go to 33 days with atmospheric supplies and no food and water. The engineers postulated that man could tolerate a 15% body weight loss from starvation concurrent with a 20% loss from dehydration.

• **Zero g—a new way**—Douglas Missile and Space Division described a novel method they are using to simulate weightlessness on the ground. Three helium-filled balloons enshrouded by a 28-ft. parachute canopy were attached to a man by means of a Navy MA 1 step-in-type harness assembly. Two small balloons were attached to the subject's arm.

Results of a number of tests show that test performance under normal gravity was generally superior to that under reduced gravity, although it varied from test to test. Perhaps the most significant thing about the report is that it showed that the balloon method may be an excellent predictor of performance under conditions of reduced gravity on force and torque tests.

• **Maneuverable unit for man**—Bell Aerosystems Co. presented its one-man self-maneuvering unit (M/R, Nov. 13, p. 29) and discussed some of its applications to space travel. The device was designed to minimize the control difficulties a man would experience when he moved a limb—thus moving his center of mass. The rocket belt places multiple-reaction control nozzles around his center of mass, minimizing rotations.

According to Bell engineers, the belt was satisfactorily tested almost a hundred times at Wright-Patterson AFB in half-minute zero-g tests.

The company also proposed two units for use by men in open space. One, a bench-like arrangement, enclosed an attitude control system and had translational control jets mounted on the frame. This unit would provide attitude stabilization and attitude control in each of the three axes, as well as translational control.

Another unit proposed by Bell is a rigidly encapsulated system somewhat resembling a huge beetle. The unit would contain one man, an entire life support system, tools, etc., and have all the maneuverability and stability of the bench system. Bell said that analytical studies of the system showed that it could be built with considerable flexibility and light weight.

The company also indicated that it was planning to build a six-degree-of-freedom simulator, which would enable it to develop orbital worker systems.

• **Maintenance techniques**—Dr. Milton Weiss of American Machine & Foundry said that man does not necessarily have the ability to make the right decision or choose the proper option when faced with a system deviation or malfunction in space vehicles. He pointed out that since space systems will be so complex, with the flight situation changing so rapidly, man may not remember the order of his choices of decision. Therefore, he said, a man-machine combination must be utilized, with man providing the failure inputs to a computer to reduce complexity of instrumentation. The machine would then furnish him with the correct decision.

Dr. Weiss' statement about the ability of man to make decisions touched off more discussion than any paper presented at the conference.

In another paper on maintenance techniques, the Radio Corp. of America said that presently available methods will not be adequate for long-duration missions.

They said the best system would be a high-speed automatic tester using high-density packaging, remotely controlled. However, since this would be so expensive in weight, the most practical method is to monitor performance parameters of components and detect faults before complete failures. ■





*Reason*

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Guided Missiles Range Division of Pan American World Airways, Inc., as prime contractor to the U. S. Air Force at Cape Canaveral, is increasing technical staffs in Planning, Engineering and Operations of the Atlantic Missile Range.

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All qualified applicants will be considered for employment without regard to race, creed, color or national origin.



GUIDED MISSILES RANGE DIVISION

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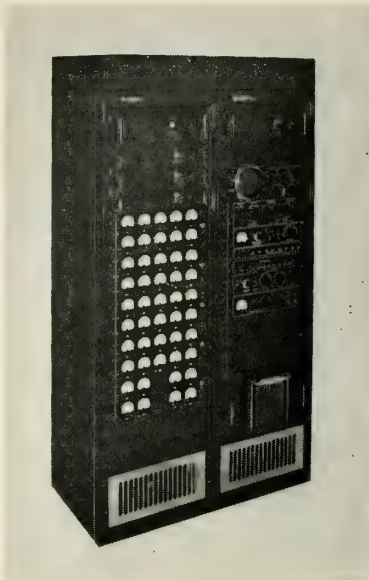
## New Product of the Week:

### PCM/Video Ground System

A PCM/VIDEO SYSTEM which meets all IRIG requirements and provides automatic reduction of serial digital telemetered signals from any data source conforming to the spirit of IRIG recommendations is being marketed by Monitor Systems, Inc.

Designed for maximum versatility, the system provides several modes of operation. An output is supplied for recording directly on magnetic tape in serial form. Data for digital-to-analog conversion and quick-look analog display may be selected. Data may also be fed directly in real time to a general purpose digital computer, or selected data may be recorded in any digital computer format.

Automatic tracking circuits vary the internal clock frequency to follow changes in the incoming bit rate. An internal PCM signal simulator provides digital inputs for complete checkout of the ground station. The PCM simulator permits convenient calibration of the



analog quick-look displays. Absolutely no adjustments are required by the new system.

Circle No. 225 on Subscriber Service Card

## Delay Line Network

A multi-tap high accuracy delay line with excellent high-frequency response is available from Columbia Technical Corp. The unit, Type CTC-1068 "Q-Line" has an 8 mc bandwidth for an overall delay of 6.3 microseconds, at an impedance level of 200 ohms. The resulting rise time is 0.08 microsecond, yielding a delay-to-rise time ratio of about 80:1. The Q-line has 63 taps spaced at 0.1 microsecond intervals. Overall delay as well as tap delay accuracy are  $\pm 1\%$ . The temperature coefficient of delay is 30 ppm/ $^{\circ}\text{C}$ .

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## Adaptable Pulse Generators

The Electronics Division of Bulova Watch Co. has available a line of highly adaptable pulse generators and voltage reference sources.

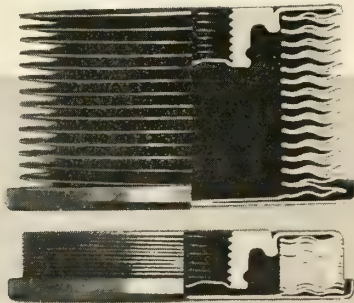
Requirements for pulses with rapid rise times at high stabilities can be met with a unit which incorporates a blocking oscillator as the pulse-forming circuit with a crystal-controlled oscillator drive. Another pulse generator available

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utilizes an astable multivibrator, housed in an oven, to provide good frequency stability over a wide range of ambient temperatures, to supply pulses at a fundamental frequency and also at twice the base frequency.

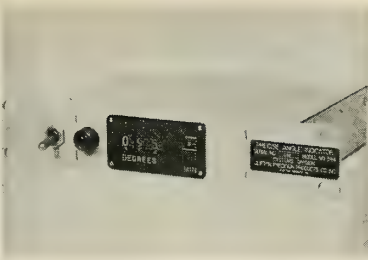
Among the voltage reference sources is a new unit well suited to missile applications because of its very small size, high accuracy, stability, and reliability. This unit, model MB151ZE, operates over an ambient range of -55° to +90°C. Voltage ranges between 5 and 28 vdc are available.

Circle No. 227 on Subscriber Service Card

## Beryllium Analyzer

Kleber Laboratories, Inc. is marketing a beryllium analyzer for laboratory use. This unit, Model BAL 35, has been developed in response to the requirements for rapid analysis of beryllium-containing ores, process streams, etc. The detection technique is based upon the unique reaction, Be<sup>9</sup>(V,n)Be<sup>8</sup>. Utilization of a radioactivity antimony source provides the gammas which are necessary to initiate the reaction. The resultant neutrons are then counted, using a new design circuitry for maximum sensitivity and minimum background. Five milligrams of BeO are readily detectable in a one-hundred-gram sample.

Circle No. 228 on Subscriber Service Card



## Precise Angle Indicator

A precise angle indicator which accurately reproduces and displays in digital readout any angular displacement signalled by a remotely located synchro transmitter is in production at Clifton Precision Products Co., Inc.

When the external synchro transmitter is displaced, the analog signal produces an error voltage which is amplified to drive the servo motor until a null is obtained. The servo motor is coupled through a precision gear train to the synchro control transformer, and a counter mechanism is placed in the gear train to accurately reproduce and display the angle. Standard accuracy is ±6 minutes maximum, repeatability is ±1 minute, while readability is 0.5 minutes. Slewing speed is 25°/sec. nominal.

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## 400-Milliwatt Transistors

PNP silicon alloy transistors which have proved excellent for switching and chopping are now available from Western Transistor Corp. The devices feature an extremely high rate of reliability and meet MIL-S-19500B specifications. Their low collector saturation resistance (less than 10 ohms) provides a desirable characteristic for switching applications. Low offset emitter voltages, leakage currents into the "nano-amp" range, and high voltages in the reverse configuration enable them to perform unusually good chopper service. The WesTran devices are manufactured in the 2N327A series and 2N1228 series. For special application within both the series, units can be furnished in dual matched pairs.

Circle No. 230 on Subscriber Service Card

## Paired Frequency Filters

Dytronics Co. of Columbus, Ohio, is manufacturing two separate variable-frequency filters mounted in a single package. The two filter sections may be used in separate circuits as individual filters or may be cascaded to produce additional response characteristics. Each filter section can operate as either a low- or high-pass filter with cutoff frequen-

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cies adjustable from 1 to 100,000 cps. Each filter section has a nominal attenuation rate in the stop-band of 36 db/octave. If the filters are cascaded and operated as either low or high pass, the attenuation rate doubles. The unit may also be used as a band-pass filter with individual control over both the high and low cutoff frequencies.

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## Variable Attenuators

Microwave Associates, Inc. has in production four calibrated variable attenuators for power level adjustment in microwave equipment and laboratory test applications. The two types offered are well shielded, compact, rugged, economical, and operate at temperatures up to 130°C. All units feature low bilateral VSWR, 1.20 (max.), negligible rf leakage, and anti-backlash construction. The attenuating vane in Type 1 (MA-527A and MA-670) is controlled by a micrometer mounted atop the control box to assure anti-backlash operation combined with accurate reproducible calibration. In type 2 (MA-580A and MA-587) the attenuating vane is controlled by a spring-loaded knob driven tuner with a device for locking at any desired value of attenuation.

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## new literature

**THERMOCOUPLE CATALOG** — A 56-page catalog (TC13A) on the comprehensive line of thermocouples for industrial application is available from the Wheelco Industrial Instruments Division of the Barber-Colman Co. The catalog carries not only descriptive information on these products, but engineering information on thermocouple usage and application.

Circle No. 200 on Subscriber Service Card

**ANTENNAS**—A catalog covering large parabolic antennas is available from the Andrew Corp. It discusses their new patented HUBLOC construction, which provides added strength and stiffness while reducing weight. Specifications on 28- and 60-ft.-diameter reflectors are given with information on antenna feeds, reflector surfaces, supports, mounts and radomes.

Circle No. 201 on Subscriber Service Card

**CONTROL VALVES**—An 8-page Control Valve catalog DCV-1 is available from OPW-Jordan. The booklet shows OPW-Jordan's complete line of Control Valves from 1/4-6 in. sizes; metals available including ductile iron, cast iron, cast steel, stainless steel, bronze, monel,

and aluminum; pressure and temperature ratings; features; capacity charts; names of parts; dimensions; flow chart; diagrams of various hook-ups; sample specifications; and information on when to use a controller and when to use a positioner.

Circle No. 202 on Subscriber Service Card

**RECORDERS**—Catalog information on Multipoint Recorders is available from the Wheelco Industrial Instruments Division of the Barber-Colman Co. The catalog sheet includes descriptive information and specifications of Multipoint Recorders up to and including 24 points.

Circle No. 203 on Subscriber Service Card

**POWER SUPPLIES**—A catalog which describes a complete line of high-efficiency, compact, highly regulated d-c power supplies is available from Valor Instruments, Inc. The switching pre-regulator (an instrumentation which offers essentially lossless regulation) is explained, together with its application as a power supply pre-regulator. The complete line illustrated in catalog PS961 includes modular, rack and cabinet models for both O.E.M. and laboratory applications. The outputs range from 200 milliamperes to 30 amperes and 60 volts with regulations of 0.01% and 0.1%.

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## names in the news



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**Dr. Walter S. Baird:** Chairman of the board of Baird-Atomic, Inc., has been added to the board of directors of Dynamics Research Corp., Stoneham, Mass. **Sims McGrath** has been elected to the same board.

**Theodore Gold:** Former Wall Street security analyst has joined Dunn Engineering Corp. of Cambridge, Mass., as vice president and treasurer.

**Herman Kockritz:** Appointed vice president of the Benematic Division, Benerson Corporation, Evansville, Ind. He will direct sales and marketing plans for the division. Kockritz was formerly industrial marketing manager for Lear, Inc., of Grand Rapids, Mich.

**Thomas K. Fox and David Westermann:** Elected vice president, and vice president and general counsel, respectively, of Hazletine Corp., Little Neck, N.Y. Fox's duties will be in administrative control, corporate operational planning and policy formulation. Westermann, in addition to his legal duties, will have responsibilities in management.

**Dr. Paul D. Greenberg:** Named to head the new Command System Department at System Development Corporation, Santa Monica, Calif. The department will carry out a multimillion-dollar contract from the Advanced Research Projects Agency for research and development in command and control systems.

**Algert G. Grimaila:** Appointed chief engineer for Space Technology at Western Center, Motorola Military Electronics Division, Scottsdale, Ariz. In the newly formed division he will further expand Motorola technology in the space electronics field, direct technical studies and proposals on space programs, and supply engineering support to the Marketing Division. Grimaila has been with Motorola for eleven years in various capacities.

**Paul E. Brodrick:** Elected to the newly created post of vice president-finance; **Courtney Moe** and **Royce B. McKinley** to membership on the board of Ultrasonic Industries, Inc., Plainview, L.I., N.Y. Brodrick is vice president and treasurer, McKinley is vice president and secretary and Moe is management associate of a partner company.

**Paul B. Wishart,** President of Minneapolis-Honeywell Regulator Co. since 1953 has been elected chairman of the board and chief executive officer, succeeding **Harold W. Sweatt**, son of the company's founder, who has been named chairman of the finance committee. Wishart's career with the company spans a 20-year period. **James H. Binger**, former vice president and director, succeeded Wishart as president. At the same time a third executive vice presidency was created and **Stephen F. Keating**, also a vice president and member of the board, was elected to the new post.

**W. D. Jones:** Named manager of market planning for B. F. Goodrich Aerospace and Defense Products. He has been with the company for almost 20 years, having joined as a sales engineer. Prior to his present position he was manager of rocket motor sales at Rialto, Calif.

**Joseph A. Ricca**, formerly a management consultant in the fields of marketing and general management, and **Charles H. Sword** have joined Ford Motor Company's Aeronutronic Division. Ricca, who has held positions with Hubbard and Company, DuMont, and Norden-Ketay Corp., was named manager of planning for electronics operations; Sword was selected as manager of operations staff for electronics operations. He was previously with North American Aviation's Autonetics Division.

**William F. Sauers:** Former president of the Aircraft Radio Corp. has been named assistant to the president of Autonetics Division of North American Aviation, Inc. He was formerly associated with The Martin Company and Booz, Allen and Hamilton.

**Norman C. Pickering:** Elected president and director of Astrosonics, Inc., Syosset, N.Y. He was formerly vice-president and technical director of Avien, Inc., president of Charles Denning, Ltd., and founder and president of Pickering & Co.

**Roy W. Fox:** With Hamilton Standard division of United Aircraft Corp. since 1949, has been appointed chief of industrial engineering, while also continuing to direct the division's cost engineering activities.

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## contracts

### AIR FORCE

\$24,600,000—North American Aviation, Inc., Los Angeles, for production of *Hound Dog* missiles and *Minuteman* missile guidance sets.

\$20,000,000—General Dynamics/Astronautics Corp., San Diego, for activation of Atlas ICBM silo squadrons to accept the *Atlas F* version. Work will be done at San Diego, Vandenberg AFB, Calif., Schilling AFB, Kan., Lincoln AFB, Neb., Altus AFB, Okla., Dyess AFB, Tex., Walker AFB, N.M., and Plattsburgh AFB, N.Y.

\$15,750,000—International Business Machines Corp., New York City, for technical services on maintenance and logistics support for *Sage* computers.

\$9,136,605—Lockheed Aircraft Corp., Sunnyvale, Calif., for production and installation of tracking and communications equipment for satellite.

\$8,727,000—Aerojet-General Corp., Sacramento, Calif., for production of *Titan II* propulsion systems and related items and for production of *Titan I* propulsion systems and related spares (2 contracts).

\$5,592,464—Burroughs Corp., Detroit, for coordinating data transmitting sets.

\$5,240,000—Boeing Co., Seattle, for research and development in connection with hardened and mobile *Minuteman* weapons systems and for engineering planning and studies, field assembly and checkout and engineering testing of the *Minuteman* weapons system (2 contracts).

\$4,500,000—Pratt & Whitney Aircraft Division, West Palm Beach, Fla., for advanced engine development for liquid-hydrogen rocket engines for the *Centaur* program.

\$4,219,000—Martin Co., Denver, for procurement for *Titan I* follow-on missiles.

\$4,000,000—General Dynamics Corp., San Diego, for development of high-impulse upper-stage vehicle for the *Centaur* program.

\$2,100,000—Philco Corp., Palo Alto, Calif., for production of satellite control systems.

\$2,035,000—American Bosch Arma Corp., Garden City, N.Y., for research and development on the *Atlas* inertial guidance system.

\$1,576,200—General Dynamics Corp., San Diego, for research on a multiple interceptor satellite concept applicable to the ballistic missile boost intercept program.

\$1,500,000—McDonnell Aircraft Corp., St. Louis, for modification kits for *GAM 72* missiles.

\$1,260,000—Lockheed Aircraft Corp., Missile and Space Co., Sunnyvale, Calif., for fabrication and test of *Agenda D* vehicles.

\$1,251,926—Allis-Chalmers Co., Harvey, Ill., for manufacture of diesel generators for the *Minuteman* installation at Ellsworth AFB, S.D.

\$1,231,000—Hughes Aircraft Co., Culver City, Calif., for technological investigation of an advanced-base interceptor.

\$1,197,000—Space Technology Laboratories, Inc., Los Angeles, for technological investigation of advanced space-based interceptors.

\$1,000,000—Space Technology Laboratories, Los Angeles, for development work on spacecraft for the *Vela Hotel* program.

\$300,000—McCormick-Selph Associates, Hollister, Calif., for solid-propellant gas generators.

### ARMY

\$14,349,192—Western Electric Co., New York City, for work on the improved *Nike-Hercules* acquisition radar, work to be done at Western Electric's plant at Burlington, N.C., and the General Electric plant in Syracuse, N.Y.; and for *Nike-Hercules* ground guidance and control equipment, work to be done at Burlington, N.C., Douglas Aircraft, Santa Monica, Calif., and Continental Can plant, Chicago. (2 contracts).

\$5,000,000—Raytheon Co., Lexington, Mass., for *Hawk* missile ground support equipment, work to be done at plants in Andover, Waltham and Dighton, Mass.; and for continued R&D on the *Hawk* missile system, work to be done at Bedford and Wayland, Mass.

\$1,700,000—DeHavilland Aircraft Corp. of Canada, Ltd., from Canadian and U.S. Governments, for work on the U.S. Army's *Mauler* air defense weapon system.

\$1,146,000—Western Electric Co., Inc., New York, for procurement of spare parts for repair of *Nike-Hercules* (3 contracts).

\$589,166—Raytheon Co., Lexington, Mass., for stabilized magnetron assembly and for repair parts, both for *Hawk* missile systems (2 contracts).

### MISCELLANEOUS

\$135,000—The Hoover Co., Electronics Division, Timonium, Md., from Boeing Co., for electronic test equipment for the *Minuteman* weapon system.

### NAVY

\$2,250,000—Westinghouse Electric Corp., Air Arm Division, Baltimore, for underwater launch and sea energy recorder systems for *Polaris* missiles.

\$2,102,948—Norris-Thermador Corp., Los Angeles, for *Zuni* metal parts.

\$2,000,000—Fairbanks Morse & Co., New York, for providing 12 diesel-powered generating sets for a new submarine tender, the AS-32, being constructed to support the *Polaris* missile program.

\$1,800,000—DuKane Corp., St. Charles, Ill., for manufacture of classified, highly specialized electronic components for static missiles (a new type of sea mine).

\$264,989—Walter Dorwin Teague Assoc., New York City, for documentation services for *Terrier*, *Tartar* and *Talos* guided missiles and their associated test equipment.

### NASA

\$419,100—Blount-Todd, for fabrication, installation and checkout of steel launch pedestal for *Saturn* launch complex 37 at Cape Canaveral.

\$316,934—Jackson and Moreland, Inc., Boston, for architect engineer design services for a lunar landing research facility.



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## —when and where—

### DECEMBER

**Eastern Joint Computer Conference**, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C., Dec. 12-14.

**Wright Brothers Lecture**, sponsored by Institute of the Aerospace Sciences, Smithsonian Institution, Washington, D.C., Dec. 18.

**Annual Meeting, American Association of Advancement of Science**, Denver, Dec. 26-31.

**Annual Meeting, American Statistical Association**, Roosevelt Hotel, New York City, Dec. 27-30.

### JANUARY

**Automotive Engineering Congress and Exposition**, sponsored by Automotive Engineers, Inc., Cobo Hall, Detroit, Jan. 8-12.

**8th Annual Symposium on Reliability and Quality Control**, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

**1962 Business Outlook Conference**, sponsored by the Los Angeles Chamber of Commerce, Biltmore Hotel, Jan. 10.

**30th Annual Meeting, Institute of the Aerospace Sciences**, Hotel Astor, New York City, Jan. 22-24.

**National Plant Engineering and Maintenance Show and Conference**, Convention Hall, Philadelphia, Jan. 22-25.

**Solid Propellant Rocket Conference, ARS**, Baylor University, Waco, Tex., Jan. 24-26.

### FEBRUARY

**Western Electronic Week and Pacific Electronic Trade Show**, Las Vegas, Nev., and Los Angeles, Feb. 3-11.

**Winter Convention on Military Electronics**, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

**International Solid State Circuits Conference**, Philadelphia, Feb. 14-16.

**Tracking and Command of Aerospace Vehicles**, Institute of the Aerospace Sciences, San Francisco, Feb. 19-21.

**30th Annual Symposium on Nondestructive Testing of Aircraft and Missile Components** (Southwest Research Institute), Gunter Hotel, San Antonio, Feb. 27-Mar. 1.

### MARCH

**5th Annual Technical Conference, Society of Vacuum Coaters**, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

**Armed Forces Communications and Electronics Association**, Cape Canaveral Chapter, symposium to be held in Cocoa Beach, Mar. 6-8.

**1962 Symposium on Packaging of Chemical Products**, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, March 13-14.

**3rd Symposium on Engineering Aspects of Magnetohydrodynamics**, sponsored by Univ. of Rochester, AIEE, IRE, IAS, University of Rochester, N.Y., March 28-29.

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# The Two Sides of the Patent Coin

**L**ET'S NOT UNDERESTIMATE the importance of the battle over federal patent rights which will flare again when Congress reconvenes next month.

The 170-year-old U.S. patent system has been carefully nurtured as one of the sparkplugs of our free enterprise economic system.

Even the Russians have a patent system of sorts.

Rep. Daddario (D.-Conn.), chairman of the House Science and Astronautics Subcommittee on Patents and Scientific Inventions, has pointed out some of the patent benefits in his home state. United Aircraft traces its existence to basic internal combustion patents. Raytheon's growth is attributed, in part, to basic electronics patents. There are many other firms throughout the industry which can trace their start in life to important patents.

Rep. Mitchell (D.-Ga.), on the other hand, has cited the recent refusal of a Texas firm to accept a NASA contract because of stringent patent restrictions.

There, simply, are the two sides of the coin. Progress based on patent protection. Lack of progress stemming from refusal of protection.

"The evidence is overwhelming that the absence of patent incentives in such contracts leaves industry reluctant to expend its maximum efforts and closely held background knowledge," says Sen. Engle (D.-Calif.).

Certainly, the job will get done. There are very competent firms in the industry willing to tackle government research and development work, whatever the situation they face on patents.

But the real problem was made clear in Senate testimony early this year by Deputy Assistant Defense Secretary Bannerman:

"Many of the most competent industrial laboratories which have done the most advanced work in fields of interest to us are not normally for hire to develop products for others to make commercially. Our goal is not the mere placement of research and development contracts but the placement of those contracts with firms currently developing the most advanced technology."

In other words, we cannot today settle for less than the best—yet the patent situation may be forcing us to do just that.

The Department of Defense licensing approach to the patent question, while not itself very satisfactory to the industry, now emerges as considerably more liberal than the philosophy of NASA and the Atomic Energy Commission.

Indeed the Machinery and Allied Products Institute asserts, in a report just issued, that the more acceptable Pentagon position is in danger of being outflanked while the government backs by default into a "government-take-all" policy. It charges that this is due to lack of firm congressional policy on

patent rights in government research and development contracts.

MAPI is only one of the organizations concerned over the problem. Others include Aerospace Industries Association and Electronic Industries Association, which earlier this year issued a biting commentary entitled "An American Patent Tragedy" by Elmer J. Gorn, patent counsel of Raytheon.

With Congress accused of permitting a "government-take-all" patent policy by default, what is the situation in regard to legislation on the Hill?

At least two bills are being studied by the subcommittee on patents of the Senate Judiciary Committee.

A bill to liberalize the National Aeronautics and Space Act in favor of the license approach was passed by the House of Representatives of the 86th Congress. It was not acted upon by the Senate that year, necessitating a fresh start.

This year, Rep. Daddario introduced H.R. 1934, based on the previously approved legislation. The late Rep. Brooks, chairman of the House Space Committee, introduced a similar bill. No action has yet been taken on these.

One point, meanwhile, is being overlooked.

Before the next round starts, the major aerospace firms would gain stature if they would make an effort to turn a source of dissension within the industry into a source of strength for their patent proposals. We are referring to the fact that major missile/space firms frequently deny to their subcontractors the same rights they are demanding from government.

"Certainly, we do," the procurement director of a major firm told us the other day. "It doesn't happen often and it's almost unavoidable. But that doesn't make it right."

**A** FRANK ATTITUDE such as that is a big step toward curing a real industry sore point. Talks starting from there could clear up a lot of resentment. There is nothing more irritating to the owners of small firms than to be told that patent infringement never happens—when they well know that it does.

Mere acknowledgment of the problem would do much toward securing support of the smaller firms in the larger industry-government conflict over patents. Talks then could proceed to a more equitable solution, if one exists, of the contractor-subcontractor patent relationship.

But the major firms will find little support from small business in their patent battle until the first step is taken. The large industry associations who are so vocal in the patent fight would do well to give some thought to suggesting that to their membership.

William J. Coughlin





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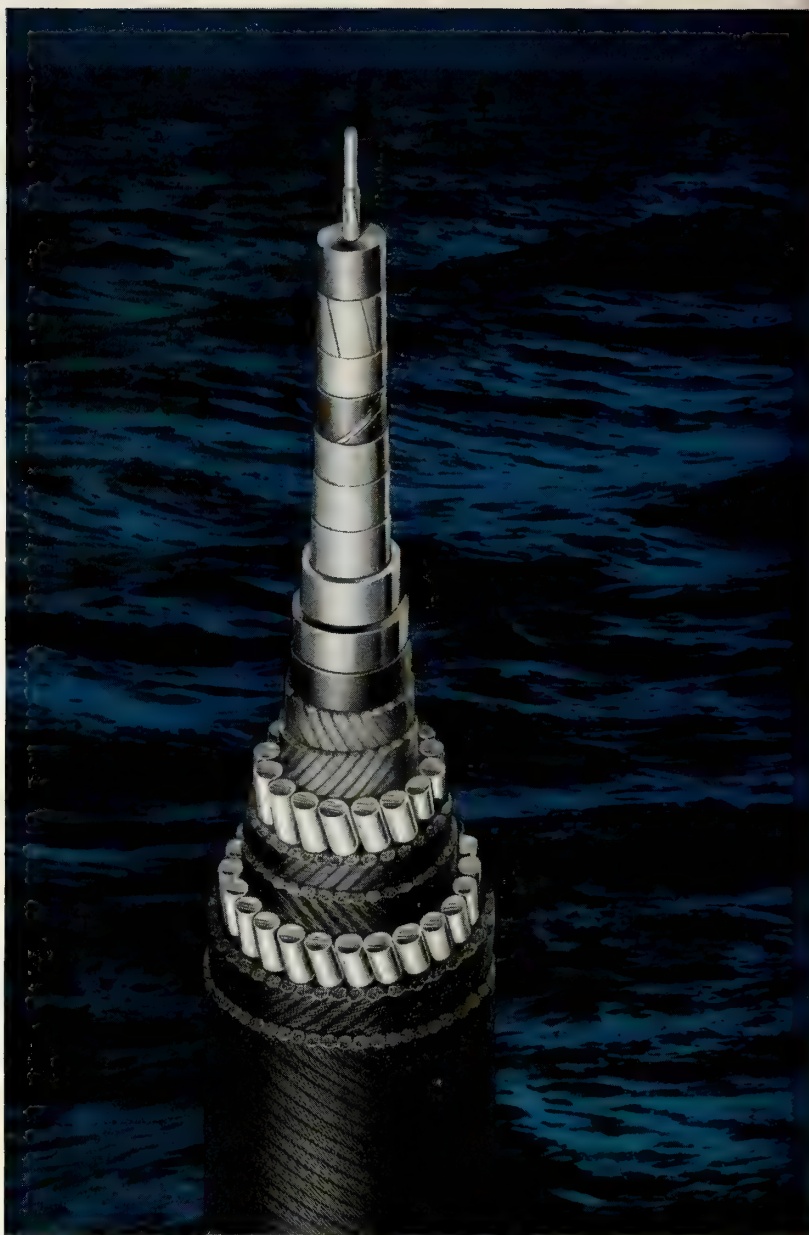
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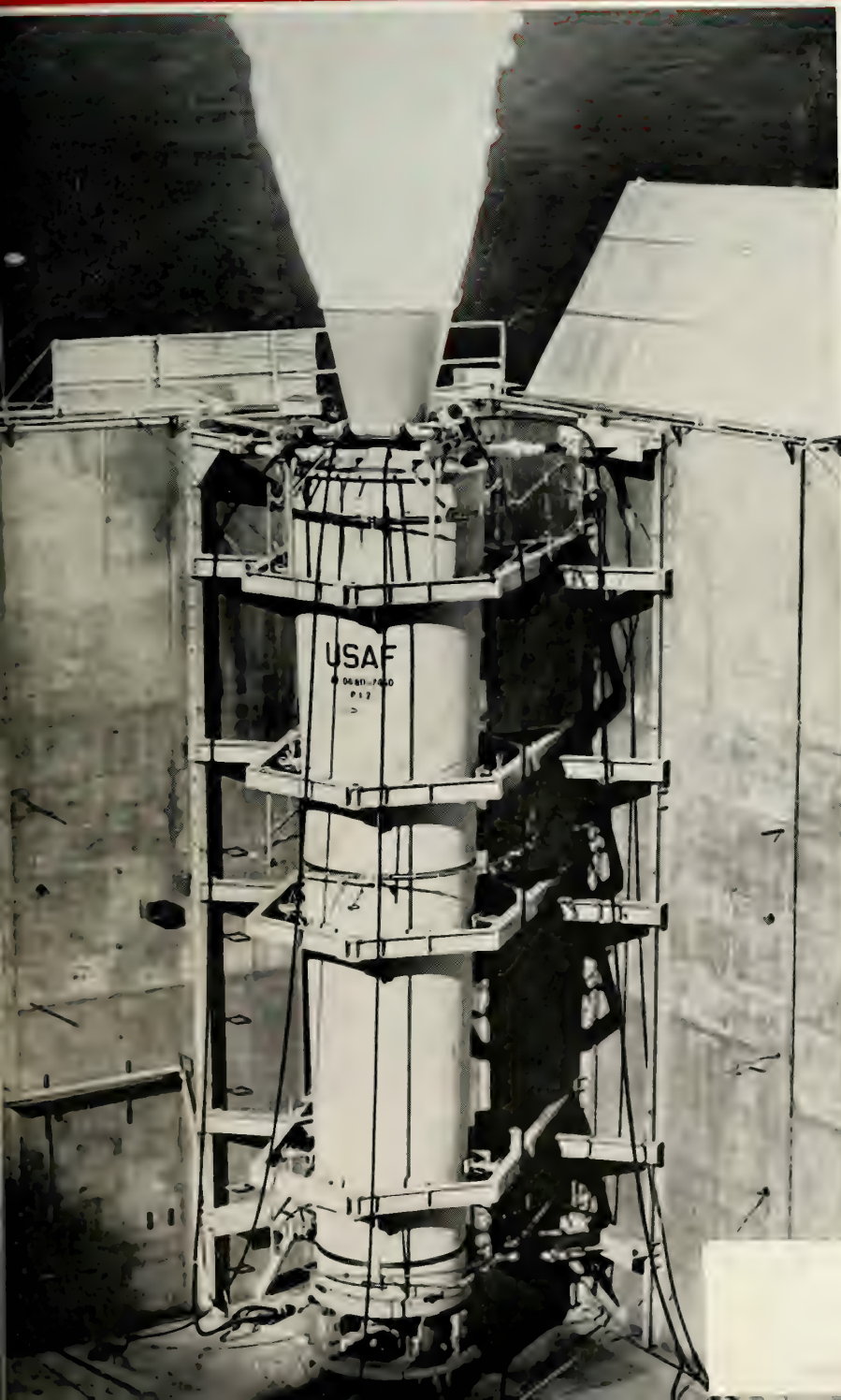
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DECEMBER 18, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY



## Boeing Wins Big Award for Saturn S-IB Stages

● **NASA Buying  
2-Man Mercury**

● **Minuteman  
Build-up Looms**

● **Details of  
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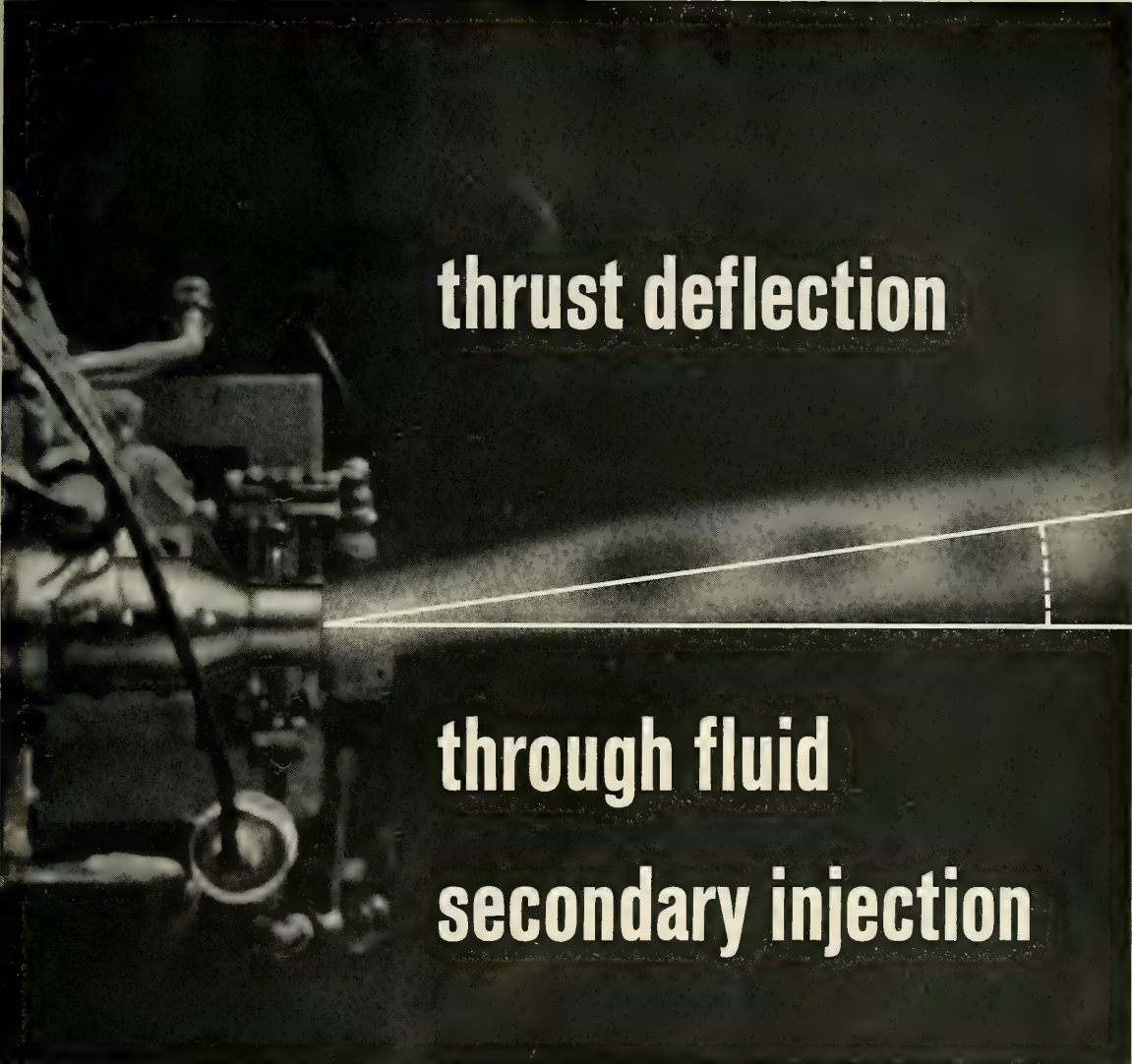
Two decades ago, the U. S. Navy ordered a compact ballistic computer from Librascope. Contracts for development of Underwater Fire Control Systems MK 104, 105, 107, and 110 followed. Today, Librascope is a logical partner in the Navy's development and production of fire control systems for ASROC, SUBROC, POLARIS and other weapons. Librascope's experience in building computer control systems for military environments is still paying off where it counts—on the front lines of our nation's defense. A note to Librascope outlining *your* control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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# through fluid secondary injection

*Photo of test conducted at AiResearch*

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# missiles and rockets

Volume 9, Number 25

December 18, 1961

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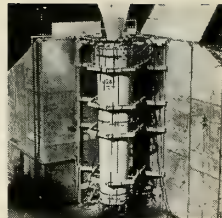
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missiles and rockets, December 18, 1961

## THE COVER

Successful firing of United Technology Corp.'s 100-in. segmented solid booster. Pentagon is about ready to ask for proposals on 120-in. solid booster. See p. 15.



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†U.S. Reg. Pdg.

M/R publishes 51 times a year. Readers are reminded that there will  
be no magazine on Dec. 25.

Season's Greetings—The Editors

38,413 copies this issue

# Worth more & why

---

*In today's defense arsenal, things cost more. They cost more because they are worth more. They do jobs undreamed of a few years ago—with reliability never believed possible.*

*Jet fighters are flying higher and faster.*

*New atomic-powered ships carry enormous strike power.*

*Missiles are thrusting farther with greater accuracy.*

*And new electronic systems, like the Hughes Tactical Attack System, are making "impossible" control jobs a daily routine.*

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**Hughes systems**, developed to meet the most advanced fighter mission problems, have paced airborne systems development. They have flown with the F-86, the F-89, the F-102, the F-106, and other U.S. Air Force, U.S. Navy and Canadian aircraft.

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over-all economy. Highly flexible in design, this new system will be as modern in the late 1960's as it is today.

It integrates three major functions—high resolution radar, weapon control auxiliaries and a navigational subsystem. Each function incorporates the latest state-of-the-art developments.

**Coolant Problems** which could be encountered in aircraft flying at multiples

of sonic speeds and at high altitudes have been solved. New techniques are being applied which provide for more efficient cooling of the thousands of electronic parts and assemblies, promising greater reliability.

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**These kinds of advancements** are the "norm" at Hughes. For they are the result of over 16 years of prime experience in the design and building of airborne systems. The new Hughes Tactical Attack System has grown out of a special, company-funded program which has been active for three years.

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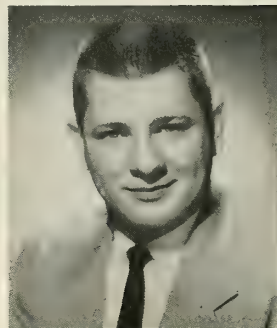
HUGHES AIRCRAFT COMPANY



# memo from the publisher



MICHAEL GETLER  
*Covers New York-New England.*



ARTHUR H. COLLINS  
*Joins West Coast bureau.*

An important part of Hughes airborne systems capability is the company's background in field service and support functions. This work, involving seven major systems, helped in the development of the unique self-test features incorporated in the new Hughes Tactical Attack System.

**Better today, better tomorrow.** The Hughes Tactical Attack System, like other major new defense systems, is worth more simply because it delivers more—in actual hardware capability and in the skills and facilities that back its success.

(1) *Hughes Tactical Attack System has all the features and technical advancements necessary to the mission.*

(2) *Hughes has one of the Free World's most efficient electronics manufacturing capabilities.*

(3) *Hughes engineers draw on experience gained in the design of systems for more aircraft than any other group.*

(4) *Hughes Field Engineers have worked with more than 16,000 airborne control systems.*

(5) *The Hughes system will not become obsolete before it flies. Rather, it is presently designed to keep step with improved aircraft performance and more demanding mission requirements.*

SOME WEEKS AGO, we mentioned our plans for putting together a strong electronics editorial team which would provide expanded coverage of this important sector of the missile/space industry.

In anticipation of this, Electronics Editor Charles D. LaFond was named a senior editor. We now are pleased to announce the appointments of the other members of the team.

After more than a month's training here in our Washington headquarters, Electronics Editor Michael Getler has reported for duty in our New York office. Mike will handle coverage of the important New York-New England area.

He comes to us with an excellent background for the job. For the past two years, Getler has been a reports writer for Raytheon's Missiles and Space Division at Bedford, Mass. There, he was engaged in writing and preparing technical reports on the company's research, development and flight-testing efforts in the guided missile field, particularly on the *Sparrow III* program. His work there, demanding close liaison with project engineers and an accurate translation of their complex activities onto paper, makes him well qualified for his new post.

Before joining Raytheon, Mike put in three years of commissioned service with the Navy, serving as an airborne air controller with a carrier-based AEW squadron. He holds the rank of Lieutenant in the Naval Reserve.

Prior to his Navy service, Getler was assistant editor of the Riverdale Press, a prize-winning New York City weekly newspaper. He is a graduate of City College of New York, where he finished in the top third of his class.

Mike and his wife, Sandra, and their two children, Belinda and Warren, are

city dwellers. A Riverdale apartment is home to them.

THE OTHER new member of our nationwide electronics team is Electronics Editor Arthur H. Collins, who has reported for duty in Los Angeles.

Art comes to us from another highly regarded electronics firm, the Librascope division of General Precision, Inc. He was an engineering writer and later served as Publications Engineer for Librascope's Aerospace Branch.

Collins received his Bachelor of Science degree in Electronic Engineering from Pacific States University in 1960. Before that, four years in the Air Force gave him a thorough grounding in electronics. He was graduated from three electronics technical schools and was an electronics instructor in the Air Training Command. He helped set up the Airborne Navigation Equipment School at Scott Air Force Base, Ill., in 1955. Art was assigned in 1956 to the training aids division at Keesler AFB, Miss., for research and development on a computer simulator for the SAGE system. He later was transferred to Hanscomb AFB, Mass., on the same project. In 1957, he received the Commendation Award from the Secretary of the Air Force for his part in the development of the SAGE system simulator.

Art and his wife, Nancy, live in Los Angeles. One of his hobbies is wild animal training, and their house pet is somewhat unusual: a 40-lb. South American ocelot!

We think our new fulltime electronics editorial team will make quite an impact on our electronics coverage. Watch for it during 1962.

*Edward D. Mihelfeld*



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# The Countdown

## WASHINGTON

### DOD's Budget: Last-Minute Adjustments

As the Kennedy Administration's FY '63 budget moved toward the printer, "sudden death" became a disease afflicting several major programs. Mobile *Minuteman* disappeared without a trace (see page 12). All funds for *Nike-Zeus* production—an estimated \$300 million to \$400 million—were reported to have vanished, at least for the present. However, the already cut request for additional *Polaris* submarines held its ground. The budget is still expected to call for about six more submarines and long-lead items for another six.

### The Nike-Zeus Game

The elimination of production money for the *Zeus* anti-missile missile from the FY '63 defense budget is not looked upon as a disastrous defeat by many of its Army supporters. The inclusion of the production money always was a phony because none of the money could have been spent until next summer. Therefore, if production money is added sometime later, after final *Zeus* tests in the Pacific begin, little will have been lost. Deployment still will have slipped another six months.

### Centaur Continues To Skid

The first launching of the *Centaur* upper stage is now expected to come in late January at the earliest—and most likely in February. NASA officials say the new earliest target date for the launching is Jan. 29. Originally, the launching was to come around October. Technical problems have interfered.

### From Eagles to Eaglets

A Navy study program is reviving the moribund *Eagle* program in the form of *Eaglet*. Essentially the *Eaglet* is understood to be a cut-down air-to-air *Eagle* missile probably designed for launching from the new TFX interceptor.

### Astronauts in Mufti

Plans for NASA's follow-on *Mercury* program call for including some civilians in the next group of astronauts to be trained. The *X-15* program is considered to be a likely recruitment area. So far, there is no decision on just how many new astronauts will be needed.

### Final U.S. ICBM Muster for '61

SAC's total operational ICBM force stands at 54 *Atlases*. The last *Atlas* squadron to be added this year—nine missiles in "Hollywood hard" launchers at Warren AFB, Wyo.—quietly became operational Dec. 12. No *Titans* are now expected to be added to the ICBM force until early spring.

## INDUSTRY

### FABMIDS Dilemma

COUNTDOWN hears the Army is debating whether to write some new *FABMIDS* (field army ballistic missile

defense system) specs and reopen the bidding. General Electric won the competition on the original specs. Three of the six entrants met the original specs—the remaining three decided they could be shaded, particularly in regard to 360° radar. Result: three heavy, three light entrants.

### R&D Intelligence

A hydrogen gas-bearing gyro developed by Sperry Gyroscope Co. is expected to triple the accuracy of SINS inertial navigator systems for *Polaris* submarines . . . Exploding bridge wire approach is being studied as a possible replacement for mine-type sonobuoy detection method in ASW . . . National Science Foundation and Office of Naval Research balloon studies of electron "dumping" (influx of electrons from the Van Allen belts to the earth's atmosphere) are expected to continue for some time.

### Apollo Rendezvous Contracts Coming

NASA is planning to let contracts by mid-1962 to determine the electronic requirements needed for *Apollo* rendezvous missions. The contracts will cover the rendezvous in orbit of *Apollo* spacecraft with advanced *Saturn* vehicles.

### British to Share AUTEK

The British are expected to join the United States in using the Navy's planned Atlantic Underwater Test and Evaluation Center—the new AUTEK Missile Range—in the Bahamas. The range is being established under agreements still to be signed with the United Kingdom. Initially, at least, all construction costs will be met by the United States.

## INTERNATIONAL

### New Skybolt Launcher?

Britain's Royal Air Force is considering a military version of the VC-10 jet transport as a platform for launching *Skybolt* ALBM's. The VC-10 could carry eight *Skybolts* . . . It's also reported that the RAF for the first time in England launched an inert *Skybolt* from a Vulcan bomber. The recent test occurred over a range at West Freugh in northern Scotland.

### NATO Defense Spending Up

Fifteen NATO nations spent \$67.8 billion—an all-time high—for defense in 1961. The figure was up \$5.5 billion over last year and includes \$51 billion spent by the U.S.

### Overseas Pipeline

The British Army is adopting British Aircraft Corp.'s *Vigilant* antitank missile . . . Nord's *C.T. 41* solid/ram-jet target drone was successfully flown for the first time Dec. 13, reaching 35,000 ft. above the Colomb Béchar range in North Africa . . . Propellant for the European space booster (*Blue Streak*) upper stages is now expected to be UDMH and nitrogen tetroxide . . . Russia is understood to be working hard at orbital rendezvous.

# The Missile/Space Week

## Soviet ICBM Force To Hit 200 by 1963—NATO Says

A NATO intelligence report estimates that Russia will have deployed some 200 ICBM's by the end of next year.

The same report also estimates that the Russians today have about 20 missile-launching submarines of which about four are nuclear-powered.

However, the report says that the Soviet missile subs can launch their missiles only while surfaced.

The statement regarding Soviet missile subs jibes generally with other reports. However, it is one of the hardest to date regarding the Russian nuclear submarine force.

## Khrushchev Boasts Stockpile Includes 100 MT-Plus Bombs

Soviet Premier Nikita Khrushchev last week claimed that Russia is stockpiling nuclear weapons more powerful than 100 megatons each.

Moreover, Khrushchev warned that his *Vostok* spacecraft could deliver the super bombs to any point on earth.

"I am not threatening," he shouted. "But I am warning you (the Western Powers) that if you want to test the Socialist countries by war you will never see the end of socialism as you will never see your own ears."

## McNamara Urges Build-up Of NATO Conventional Arms

Defense Secretary Robert McNamara issued a new plea to the European members of NATO to increase the size and power of their conventional military forces.

McNamara stressed the same theme throughout much of a meeting of NATO ministers at Paris.

He said NATO must close the existing gap between its nuclear power and its ability to fight conventional wars.

## Sixth Nuclear Test in Nevada

The AEC detonated the sixth announced underground nuclear test in

its current series this last week.

The test—conducted at the AEC's Nevada proving ground—was listed as "low yield."

Meantime, officials involved in the test program are reported to be finding the test results not as satisfactory as expected—and the need for atmospheric tests greater than previously believed.

## U.N. Space Group To Meet

The U.N. Committee on Peaceful Use of Outer Space has finally gained Soviet agreement to hold its second meeting. The date: March 31.

The agreement immediately aroused congressional suspicions. Chairman John C. Stennis of the Senate Preparedness Subcommittee warned that the United States must not let itself be "lulled into a moratorium on outer space development."

## Shots of the Week

The Air Force wound up the *Titan I* R&D test-flight program Dec. 13 with a 5000-mi. shot from Cape Canaveral.

First flight of the ICBM was on Feb. 6, 1959, and was successful. There have been a total of 40 *Titan I* shots—four classed as failures, eight as partial successes and the rest successful.

More flights of the Martin Marietta *Titan I* are scheduled from the Cape to test components for *Titan II*.

In other shots:

- The Air Force's *Discoverer XXXVI* was orbited from Vandenberg AFB Dec. 12. It carried a capsule intended for recovery and a 10-lb. piggyback satellite, *Oscar* (orbiting satellite carrying amateur radio), to beam signals to ham radio operators.

- An *Atlas F*, in another piggyback experiment Dec. 12, released a package of 28 dummy atomic fuel cells made of sodium, potassium, rubidium and cesium in a study of how metals evaporate on re-entry. The shot was from the Cape.

- A *Nike-Zeus* passed an extended flight test in the atmosphere Dec. 14 from Pt. Mugu, Calif. It glowed red-hot while going through



TRAILBLAZER II re-entry vehicle.

severe guidance maneuvers.

- A *Trailblazer II* rocket was launched Dec. 14 from Wallops Island by a team from Atlantic Research Corp., designers of the rocket. The four-stage vehicle drove a General Electric re-entry capsule down through the atmosphere from 190 miles altitude. The launch was the first of several re-entry physics experiments sponsored by NASA, MIT's Lincoln Laboratory and ARPA.

## NAA Sets Up Apollo Division

North American Aviation's Space and Information Systems Division will form a new Apollo Division to handle its multibillion-dollar contract for the U.S. manned lunar landing program.

Vice President and General Manager John Paup will direct the new division. He will be aided by Milton Sherman, Assistant Program Manager, and C. H. Feltz, Chief Engineer.

The Division will also have a program management control unit headed by C. W. Warden.

PERT program control techniques will be utilized by this office, as will other computer-type management techniques.

R. S. Risley will serve as assistant program manager for contract relations.

NASA will set up a liaison office at the division with a staff of about 20 people. In return, NAA will open an office at the space agency's Manned

missiles and rockets, December 18, 1961



Spacecraft Center in Houston.

Engineering offices will also be set up for various specialty areas including Flight Technology, Ground Support Equipment, Design and Structures, Reliability Design and Crew Safety, Project Integration, Power Systems, Space Electronics, and Bioastronautics.

### Explorer's Van Allen Data

*Explorer XII* satellite has discovered the outer Van Allen Radiation belt's constituent is protons, not neutrons as was previously believed.

NASA also disclosed that the satellite—launched on Aug. 15, 1961—stopped transmitting recently after 112 days in orbit. A malfunction in the primary power system was blamed for the failure.

Besides reporting that there are a thousand times fewer neutrons in the outer belt than was previously thought, the satellite sent back to earth more than 3 billion bits of information. It is expected to take until mid-1962 to analyze the more than 2500 miles of tape data. Project scientist Dr. Frank McDonald, of NASA's Goddard Space Flight Center, said that the satellite also sent back important information concerning the design of solar-powered satellites which have to traverse the radiation belts.

### TRAAC Assuming Attitude

Partial activation of the gravitational stabilization experiment aboard the Navy's *TRAAC* satellite (M/R, Nov. 27, p. 29) may have been accomplished.

Tracking stations report that the vehicle appears to be slowly stabilizing into approximately the predicted earth-oriented attitude. It will be 2-3 weeks before results are known.

APL scientists triggered the device aboard the satellite on Nov. 24. It was to have released a weight and boom arrangement causing the craft to direct one face towards earth at all times. The signal indicating completion of the boom extension was not received at ground stations. Scientists speculate that the failure was due to a mechanical breakdown in the small activating motor. However, partial release of the stabilization equipment is indicated by the slow movement into the prescribed attitude.

### S-48 Gear Checks Out

Ionospheric test equipment slated to go aboard the *S-48* satellite this summer performed well during two suborbital rocket rides, according to an analysis of data taken during the June and October flights by the National Bureau of Standards Radio Propagation Laboratory.

NBS, under NASA sponsorship, is participating in an international program aimed at collecting new information on ionospheric phenomena.

The instrumentation was carried aloft from Wallops Island, Va. by four-stage *Javelin* rockets to a peak altitude of about 600 miles. The payloads each remained above the ionosphere layer for about 14 minutes. The *S-48* vehicle, called a Top-side Sounder, will remain operational above the ionosphere for from 6 to 12 months and will supply data on top-side electron densities, ionization diffusion in the F-2 layer, vertical movements, tidal fluctuations, and properties producing ionospheric storms.

When in orbit, the *S-48* will transmit a pulsed radio wave down towards the upper layer of the ionosphere and telemeter the reflected signal to ground stations. This is basically the same method used in ionospheric measurements made from earth. Peak power requirements for top layer soundings are expected to be considerably below those needed from terrestrial sites.

### First Houston Contract Let

First step towards construction of NASA's new Manned Spacecraft Center in Houston was a \$1.5-million architect-engineer award last week to Brown & Root, Inc., of Houston.

The contract, which will be supervised by the Fort Worth district of the Army Corps of Engineers, includes master planning for the complete installation, site development, design of the flight project facility, flight operations facility, equipment evaluation laboratory, and some utilities. Design engineering for the environmental test lab is not included in this initial contract.

Completion of the Houston firm's effort is expected in about six months, but letting of the first construction contract is anticipated in February.



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# Faster ICBM Deployment Looms

**Swelling of hardened Minuteman force, at expense of mobile Minuteman, may yield increase of 300 by July; total deployment of 1500 could result; Pentagon increasingly interested in development of MRBM, mobile ICBM**

by James Baar

THE KENNEDY Administration is moving toward a new acceleration of ICBM deployment—apparently as a result of Soviet defense budget boosts.

The tip-off came in a last-minute Defense Department budget move on Dec. 13 killing the mobile *Minuteman* R&D program in favor of a considerable expansion of the authorized force of hardened and dispersed *Minutemen*.

The Soviets on Dec. 6 announced the second major increase in their defense budget in less than six months. Under the ruble-dollar detection and translator system used by many experts in deciphering Soviet military budgets, the new increase amounts to nearly \$5 billion and the total increases over the last six months to \$18 billion to nearly \$20 billion.

The Soviet military budget for 1962 is now estimated to total nearly \$60 billion. The U.S. defense budget for FY '62 is expected to total between \$51 billion and \$52 billion.

• **300 increase**—The total authorized *Minuteman* force is expected to be expanded to about six 150-missile wings—an increase of 300 missiles over the total authorized through FY '62.

No new production schedule has been completed so far. However, it is expected that the production rate and deployment rate will be increased considerably rather than merely extended.

Previous plans have called for deploying the first 600 *Minutemen* in hardened silos by about 1964. If site construction were started quickly enough, this number could be augmented in the same time period by one and possible both additional wings.

So far, deployment plans call for *Minuteman* wings at Malmstrom AFB, Mont.; Ellsworth AFB, S.D.; Minot AFB, N.D.; and Whiteman AFB, Mo. Soil borings for possible site construction have already been made at Reese AFB, Texas; Tinker AFB, Okla.; and Pease AFB, N.H. More soil borings are planned at Glasgow AFB, Mont.; Grand Forks AFB, N.D.; and Warren AFB, Wyo.

If all sites are used, total *Minuteman* deployment could reach 10 wings—1500 missiles.

No acceleration of deployment would have been possible with the mobile *Minuteman*. The program for putting the solid fueled ICBM on railroad cars has slipped badly over the last year because of budget cuts. At the time of its entombment it still faced a number of tough technical problems.

• **New mobile missiles**—However, the expansion of force levels was not the only consideration in the decision to kill the mobile *Minuteman*. Two other important factors were:

—The Pentagon's plans to develop a highly-mobile MRBM.

—Increasing Pentagon interest in developing a new, mobile ICBM.

Both new missiles, unlike *Minuteman*, would be designed to begin as mobile systems. Both would be based on the use of improved nuclear warheads which are expected to be developed and tested over the next year.

The double decision on *Minuteman* abruptly reversed earlier plans incorporated in the draft of the FY '63 defense budget. The mobile R&D *Minuteman* program was to be resumed after a stretch out of one year. No

additional *Minuteman* wings were included despite strong Air Force objections.

To date, a total of \$108 million has been spent on the mobile *Minuteman* program. The Eisenhower defense budget for FY '62 requested \$220 million for the mobile program, but this was totally eliminated by the Kennedy Administration at the same time that the hardened and dispersed program was accelerated earlier this year.

The Kennedy budget revision also included \$36 million to build standby production facilities for *Minuteman*. These facilities make it possible to double *Minuteman* production.

But, if maximum benefit was to be derived from the capability to double production, the Air Force made clear that the decision to use it had to be made earlier this fall in order to begin constructing more bases in time. Moreover, the Air Force has called for the deployment of more than 2000 *Minutemen* rather than the 900 now expected to be proposed.

The Kennedy Administration has been reluctant to accelerate the deployment of ICBM's further for fear that such a move would excite the Russians into increasing their ICBM deployment.

Also, the Administration has been having considerable difficulty in keeping the FY '63 defense budget under \$52 billion. Accordingly, Administration officials have not been overly hospitable to arguments in favor of a greater margin of strategic security.

Apparently, it took the new Soviet defense budget and related ominous information to bring about at least a partial conversion. ■



NASA EXPECTS to pour about \$250 million in the next 18 months into its new two-man follow-on *Mercury* spacecraft. The first bell-shaped capsules are expected off the assembly lines late next year.

Last week NASA was still looking for a name for the new project—which will have a primary mission to test orbital rendezvous.

First flights are planned for 1963. If successful, some space agency officials believe two years can be cut off the 1967 target date for the manned lunar landing of an *Apollo* spacecraft—thus providing the U.S. with a chance to beat Russia to the moon.

It will also permit training for additional U.S. astronauts during one-week orbital flights and serve as a test bed for *Apollo* sub-systems and flight theories.

The program's total cost is estimated at \$500 million, but it will probably be higher. Approximately 50 per cent of this is slated to go to McDonnell Aircraft Corp. — builder of *Mercury* — which NASA has selected as prime contractor.

Almost all of the remainder will go to General Dynamics/Astronautics, Martin Marietta Corp., and Lockheed Aircraft Corp., for the *Titan II*, and *Atlas Agena B* to be used as launch vehicles.

NASA officials report that \$76 million is already allocated for the program in the next six months. McDonnell will get \$40 million with the remainder split among the launch vehicle prime contractors.

• **12 capsules**—Another \$200 mil-

# First Two-Man Mercuries Next Year

**Still-to-be-named project to test orbital rendezvous, cost \$500 million or more.**

by Hal Taylor

lion is expected to be earmarked for the program in the space agency's fiscal 1963 budget. The \$500 million estimate for the total cost of the program includes about 12 spacecraft, plus *Atlas Agena* and *Titan II* launch vehicles.

The NASA announcement of the new program Dec. 7 confirmed M/R exclusive reports that it was coming (10/9/61 p. 16; 10/16/61 p. 17; and 12/4/61 p. 14).

The new program originates in a

proposal from McDonnell and a NASA desire to test orbital rendezvous and the reactions of astronauts to the rigors of one week space flight—the same length of time involved in going to the moon and back.

The new spacecraft will be the same shape as the current *Mercury* capsule but will be far larger and much more sophisticated. It will be able to return to land instead of water, use a glide wing during re-entry and will have ejection seats for low-altitude astronaut escape besides being equipped for rendezvous docking operations. The most significant changes from the *Mercury* capsule include:

• **Size**—It will be 1 ft. larger than the current 74 in. base of the *Mercury* capsule and it will be lengthened proportionately to provide a 50 percent increase in cabin space.

• **Weight**—It will be two to three times as heavy as *Mercury*, weighing about 4000 lbs. during its early flights and 6000 lbs. during the rendezvous flights.

• **Boosters** — Martin Marietta Corp.'s *Titan II* vehicle will be used to put the spacecraft into orbit. Its second stage will be upgraded from 15,500 to at least 17,500 miles per hour. General Dynamics/Astronautics' *Atlas* missiles will place *Agena B* vehicles into orbit for the rendezvous attempts with the spacecraft.

• **Propulsion** — Six variable-thrust engines—two for each axis—will be used for maneuvering during orbit. The propellant will be hypergolic—hydra-

(Continued on next page)

## Saturn S-IB Contract May Be Worth Over \$1 Billion

BOEING CO. has won NASA's biggest launch vehicle contract—over \$300 million for the *S-IB* stage of the advanced *Saturn* booster.

While the contract is officially valued at over \$300 million, informed sources report that its total value will easily approach—and possibly surpass—\$1 billion.

The contract will run through 1966. It calls for the development, construction and testing of 24 flight boosters plus several ground test versions. Boeing has named Rocketdyne Division of North American Aviation, Inc., to assist in the ground-firing of the boosters.

Meanwhile, it was also disclosed that:

• While NASA has decided to move ahead with development of the large *Nova* vehicle, there are no funds remaining in the Fiscal '62 budget for the program. Real work on development of the launch vehicle must now await either a supplemental budget request or the Fiscal 1963 budget which will go to Congress in January.

• The Golovin committee was unable to decide whether the U.S. should build a 160-in. or 240-in. solid motor. As a result, it recommended that before production begins, the Air Force should initiate further feasibility studies.

The space agency is giving serious consideration to a

proposal that it use a single J-2 engine developing 200,000 lbs. thrust in the *S-IV* stage of the advanced *Saturn* booster. The J-2 engine would replace the six RL-10 engine stage which would develop a total thrust of 90,000 lbs.

The *S-IB* stage of *Saturn* will be powered by a cluster of either four or five F-1 engines, which will develop a thrust of 6 million or 7.5 million lbs. respectively.

The stage will be 33 ft. in diameter and 70 to 80 ft. high, and will weigh five million lbs. at liftoff. It will be the first stage of the advanced *Saturn* launch vehicle which will boost the *Apollo* spacecraft on circumlunar missions and the manned moon landing if the orbital rendezvous technique is used.

Chrysler Corp. was selected to build the *S-I* stage of the *Saturn*, North American Aviation Inc. will build the *Apollo* spacecraft, and McDonnell was awarded the prime contract for the follow-on *Mercury* manned space flight program.

The *S-IB* stage will be built at NASA's Michoud, La., plant, where Boeing expects to employ 5000 people. Four other firms—Aerojet-General, Space Technology Laboratories, Martin Marietta Corp. and General Dynamics/Astronautics—competed for the contract.

## orbital rendezvous in '64 . . .

zine/nitrogen tetroxide. Each engine will have a thrust of 200 to 300 lbs. and will be capable of increasing the spacecraft's speed by 500 ft.-per-second during the docking operation with the *Agna B*.

- **Pilot control**—The astronauts on board will control the spacecraft during docking with the *Agna B* in orbit. No unmanned rendezvous flights will be made. For the first time, the pilots will also be able to maneuver the spacecraft during re-entry and landing.

- **Recovery** — During the early flights, the spacecraft will land in the water. In the manned orbital and rendezvous flights, it will return to land, probably on the salt flats at Edwards Air Force Base, Calif. Several other areas in the Southwestern U.S. are still being considered. During the orbital flights, there will be a 30 minute window in which re-entry can be made successfully to achieve the land landing. The capsule will fly at a 32 degree angle-of-attack during re-entry and will have a lift-drag ratio of .3.

One large parachute will be used to slow the spacecraft during reentry and it will very likely be fitted with a para-, or Rogallo-wing to enable it to glide in for the landing.

- **Pilot safety**—Each pilot will have

an ejection seat which can be used for low-altitude escape from the capsule. The pilots will sit side by side, each facing a door in the spacecraft's side. For an abort, the door will blow off and the ejection seat with its human passenger will be catapulted. A parachute will then open to lower them to the ground.

- **Subsystems** — These will be installed around the perimeter of the spacecraft so that they can be reached from the outside through doors. This will make checkout procedures much simpler.

- **Life support**—This will be very similar to the system used in the current *Mercury* capsule but it will be expanded to provide support for two astronauts for flights lasting at least one week.

With the advent of the new project, NASA's manned space-flight schedule over the next three years shapes up like this:

The first manned three-orbit flight will be attempted next month. Two and possible four similar flights will follow in two-month intervals.

Late next year, one-day orbital flights will be attempted using a modified *Mercury* capsule, in which certain equipment will be moved out of the capsule and placed in the adapter. This

will permit expansion of the life support system from four hours to one day or 18 orbits. At least two of these flights are scheduled.

The space agency will then move into the two-man capsule flights.

Several unmanned ballistic flights will be attempted from Cape Canaveral.

Then a series of one day, three day and one week manned orbital flights will be attempted beginning in 1964. Once manned flight in the spacecraft has been proved, NASA will then move into the orbital rendezvous phase of the program late in 1964.

- **Docking operation**—In the rendezvous operation, the *Agna B* will be launched by an *Atlas* booster into a 150-mile nautical orbit. It will then be tracked for approximately one day to determine its precise orbit.

The information will then be fed automatically into computers to determine the exact time that the spacecraft should be launched.

Its *Titan II* booster will send the spacecraft into an elliptical earth orbit which will vary from 100 miles to 150-mile-high altitudes.

Thus, when the spacecraft is at apogee, it will be in the same orbit as the *Agna B*. As soon as possible, the spacecraft's pilot will lock on to the *Agna B*. To do this, the pilot will utilize air-to-air sensors, transponders and electric magnetic sensing devices.

Once he is locked on his target, the closing phase will begin with the firing of the spacecraft's hypergolic engines. These will furnish the necessary propulsion to increase the speed of the spacecraft so that it can dock with the *Agna B*.

Just prior to re-entry, the *Agna B* vehicle will be jettisoned and the spacecraft will land alone.

One of the big problems facing McDonnell is the design and development of the equipment needed for the spacecraft and the *Agna B* docking operation. While both NASA and McDonnell have a general idea of what is required, this phase of the program is reported to be still in early R&D.

McDonnell was awarded the *Mercury* capsule contract on Jan. 12, 1959. The firm delivered the first flight version in February, 1960, and had turned over 13 capsules by June 30, 1960.

Total cost of the *Mercury* program is \$400 million through FY '62—including the 19 capsules which NASA has ordered. The first manned ballistic flight was made on May 5, 1961; the second in July.

The chimp "Enos" was sent on a two-orbit flight in the capsule late last month. If no more technical troubles develop, the U.S. will orbit an astronaut in the second half of the month. \*\*

### Soviets Show Model of Vostok II with Short Wings

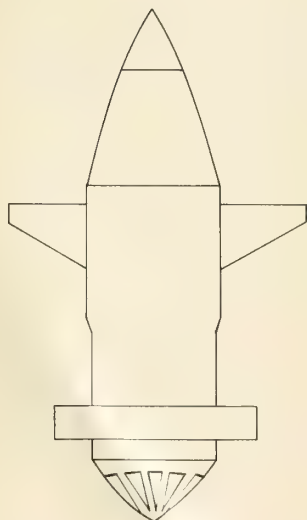
RUSSIA has unveiled a model of *Vostok II* showing the manned spacecraft with two stub wings.

The model was included in a film shown at the Russian Embassy in London recently. Soviet officials said *Vostok II* differed from *Vostok I* and the wings were new. They connected them with the maneuvers Maj. Gherman Titov reportedly carried out during the last orbits of his 17½-orbit Aug. 6 flight, when he was in denser regions of the atmosphere.

There has been continued speculation in the west that *Vostok's* were winged and that they were being designed as a military spacecraft. The model, however, is the most concrete evidence to date that this is the case.

Like a mockup of *Vostok I*, the *Vostok II* model had a tail annulus, which was provided with moving shutters or flaps. The craft was liberally equipped with long whip antennae, four at the head, four at the tail and more amidships.

There are reports that Russia is working on orbital rendezvous. The various control surfaces of *Vostok* may be designed for the necessary maneuverability in space. \*\*





# UTC Fires 100-in. Segmented Booster

**Success comes as DOD prepares to ask for proposals  
on 120-in. solid; four other major manufacturers in competition**

PROPOSAL REQUESTS for the 120-in. solid booster are expected to go out to industry from the Pentagon within the next two weeks—hard on the heels of the successful firing of United Technology Corp.'s 100-in. segmented, conical booster.

United Technology is one of the three firms currently engaged in applied research directed toward the 120-in. motor, which probably will be segmented. The others are Aerojet-General which fired a 500,000-lb.-thrust prototype last summer, and Lockheed Propulsion, which expects to fire a 120-in. motor in the near future. Along with Thiokol, all are competing for the booster contract.

Earliest use of the big solids is likely to be as a cluster around the *Titan II Dyna-Soar* booster—the so-called *Titan III*.

Fiscal '62 funding for large solid boosters runs about \$77 million—\$50 million for the booster, \$15 million for solid upper stages and \$12 million for launch facility construction.

• **Nose-down firing**—The UTC motor generated about 500,000 lbs. of thrust during the 80-sec. firing. Designated the P-1-2, the 130,000-lb. motor consisted of two 30-ton center segments and two smaller capping segments. The motor was conical, with a 1.5° taper. This conical approach

is UTC's method for large boosters.

The motor was fired nose-down in a concrete test stand designed to handle engine thrusts up to 2 million lbs. The segments were assembled at the stand under field conditions without the use of tools.

A new nozzle design was used and a liquid injection thrust vector control unit was also checked out in the firing. The 2-ft.-thick propellant charge was ignited by a "small rocket." B. R. Adelman, UTC executive vice president, said the igniter was too big to be considered a squib.

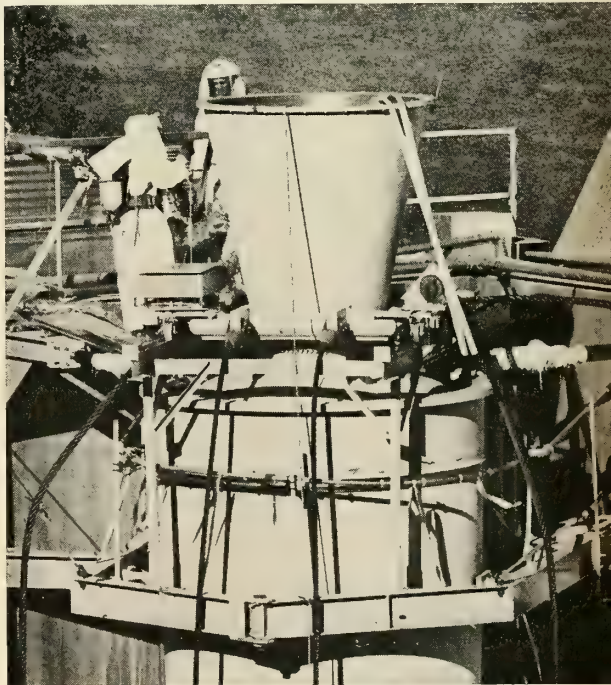
The motor had all the characteristics of a flightweight model, but its mass-fraction was not disclosed. UTC experts consider any propulsion unit with a mass fraction of more than 0.86 as flightweight.

The firing took place Dec. 9 under a recently negotiated contract with the Air Force Space Systems Division. AF officials called the test part of an expanded program to push the state of the art in solids.

UTC expects to test a 120-in. motor next spring. The firm develops prototype boosters with flightweight hardware from the beginning. Adelman says this approach is initially risky, but the gains are considerable as the associated problems are solved. ■



**SECOND MAIN** segment is lowered into position with a crane. The sections are joined with a flightweight clevis-type joint—without the use of any tools.



**TECHNICIANS** wearing protective clothing make final nozzle adjustments prior to firing UTC's 43-ft. solid motor. A liquid injection vector control was included.

# Computer Conference Reflects Boom

**EJCC told sales were \$1 billion in 1961;  
IBM discloses details of Mercury computation system**

by Charles D. LaFond

THE ELECTRONIC data processing industry delivered \$1 billion in equipment this year and current annual R&D expenditures in the field are about \$150 million.

Conceived only 15 years ago, the industry has enjoyed technological advancements adding up to one of the greatest revolutions of modern times, said Dause L. Bibby, president of Remington Rand Division of Sperry Rand Corp., keynote speaker in Washington last week for the 1961 Eastern Joint Computer Conference.

Bibby reported that over 5000 computers are in operation today, and forecasts indicate that between 10 and 15 thousand will be in use in the U.S. alone in 5 years. By 1970, he predicted, the value of communication equipment to handle data transmission among computers will be equal to the value of the computers themselves.

Examining another aspect of the U.S. computer industry, Bibby asserted that it may turn out to be our most potent weapon for national survival.

Soviet Russia has at least 200,000 more scientists and engineers than the U.S., he noted, and is producing new ones faster than we are. And the situation shows no signs of improvements.

The computer, he declared, can provide a partial answer to our manpower shortage. It can help our engineers to do more work in less time. The extent to which computers enter this equation may well decide our fate, he concluded.

• **EJCC summary**—This year's exhibits, in marked contrast with the 1960 show, returned to emphasizing military, scientific, and space computer systems.

A reduction in the number of purely business/commercial systems and an underlining of complete systems rather than components was the principal change in the first meeting sponsored by the new American Federation of Information Processing Societies.

Founded last May, AFIPS replaces the National Joint Computer Committee and presents a unified society made up of three major electronics organizations: the Institute of Radio Engineers, American Institute of Electrical Engi-

neers, and the Association for Computing Machinery.

Expecting an attendance of over 4000, nearly 90 manufacturers demonstrated their best in on-line equipment. Considering the types of systems shown, this may represent the costliest show yet in equipment dollars/square foot.

The most enormous display was that set up by Remington Rand's Univac division. It had a duplicate of the vast information retrieval center developed for ASTIA, the Armed Services Technical Information Agency. Heart of the complex, which occupied about 13 regular exhibit booth areas, was the new solid-state Univac 80 computer.

Quality of technical papers this year also was unusually high—conference officials said only 29 out of 242 submitted papers were selected for presentation.

• **Mercury computers**—For the first time, IBM's Federal Systems Division presented details of the Project Mercury data computation system. Four papers emanating from the division's Washington headquarters described (1) the role of the system digital computers, (2) programing, (3) real-time simulations and (4) the launch monitor subsystem for the project.

The first paper, by S. I. Gass, reviewed the use of digital computers in the system as an integral part of the real-time decision-making complex. These, he said, are employed to process observations made in the launch, orbit, and re-entry phases of each mission and are used to supply a continuous, up-to-date record of the non-environmental status of the craft.

Duplexed IBM-7090's at Goddard Space Flight Center, Greenbelt, Md., receive inputs during launch. Radar inputs from the worldwide Mercury tracking net are fed in continually during orbit and re-entry phases.

After processing, outputs from Goddard are returned to the giant display center at the Command Control Center, Cape Canaveral. (Total receipt, processing, and return time is about 1 sec. for a given piece of data, according to Charles L. Bradshaw, deputy director

of the computation division, Marshall Space Flight Center.)

Flight-control backup is provided by a simplex IBM 709 complex in Bermuda.

It is essential, Gass said, that both centers be capable of providing in real-time a variety of trajectory data, present position, acquisition messages, impact and other decision-making elements throughout the entire mission.

Principal subsystems feeding the Goddard 7090's include: *Atlas* radio-inertial ground guidance computers for tracking and command control of the launch vehicle; a 7090 impact prediction computer at the Cape, tied in with the Azusa beacon there and radar inputs from Grand Bahama Island, San Salvador Island and the Cape, for real-time trajectory data including position and velocity, every 0.4 second at 1000 bits/sec; down-range radar-facility inputs for range, azimuth, and elevation measurements (via the 7090 impact predictor); telemetry signals via the Cape for capsule operation and condition; and finally, smoothed radar data from the Bermuda station are fed directly to Goddard via teleprinter circuits.

• **System inputs, outputs**—Each paralleled 7090 at Goddard is connected to 12 magnetic tape drives, an on-line printer, punch and card reader, and a data communications channel (DCC, IBM-7281). The DCC permits data transmission to flow directly to and from each system's 32,000-word core memory. Each DCC handles data over 32 subchannels.

Inputs to the communications channel consist of 17 teleprinter circuits, two high-speed inputs, a WWV minute time signal, and a half-second time signal.

Outputs from Goddard are through two high-speed circuits, three teleprinter circuits, and a sense-output console. Since only one 7090 transmits processed data, the console provides switching from one computer to the other.

A description of the programing for the system, including all the modes of operation, routines, system monitoring, and computer switching was presented by M. B. Scott and R. Hoffman. ■



# National Aeronautics and Space Administration



*"Now is the time to act, to take longer strides, time for a great new American enterprise, time for this Nation to take a clearly leading role in space achievement. I believe that the nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to earth."*

The President  
of the United States  
May 25, 1961

*The nation has committed itself to accelerate greatly the development of space science and technology, accepting as a national goal, the achievement of manned lunar landing and return before the end of the decade. This space program will require spending many billions of dollars during the next ten years.*

**NASA** directs and implements the nation's research and development efforts in the exploration of space. The accelerated national space program calls for the greatest single technological effort our country has thus far undertaken. Manned space flight is the most challenging assignment ever given to mankind.

**NASA** has urgent need for large numbers of scientists and engineers in the fields of aerospace technology who hold degrees in physical science, engineering, or other appropriate fields.

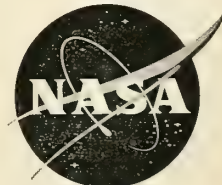
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Positions are filled in accordance with Aero-Space Technology Announcement 252B.

All qualified applicants will receive consideration for employment without regard to race, creed or color, or national origin.

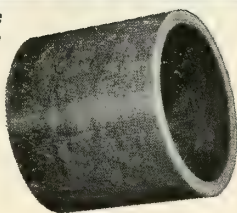


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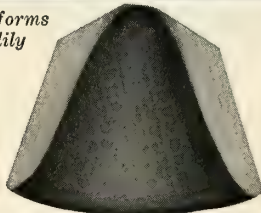
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# Technical Countdown

## ELECTRONICS

### AC Titan Guidance Passes Quarter-Year Mark

The guidance package for the Air Force's *Titan II* ICBM recently logged a quarter of a year of continuous operation. Built by AC Spark Plug, the inertial package passed the 2000-hour mark as part of an overall systems test program being conducted in AC labs.

### Centaur Slippage Benefits Some

The propulsion problems which forced a delay in the *Centaur* program have had at least one beneficial side effect. The relaxation of the previously tight schedule has enabled Minneapolis-Honeywell to incorporate design improvements of the pulse-balance electronics into the inertial guidance system.

### Radiation Hazards Overestimated

Area of the Fylingdales BMEWS station in England will be reduced by 1500 acres due to the downgrading of the expected microwave radiation hazard. This was decided after joint U.S.-U.K. studies on the operational aspects and power distribution of high-power radar systems. The site will now occupy 900 acres.

### Pneumatic Guidance Computers Next

Martin Marietta's Orlando division is pushing development of pneumatic computers for missile guidance. Division engineers believe they can produce a miniature package several orders of magnitude smaller than existing electronic types at half the cost. And tests so far indicate pneumatic systems will operate satisfactorily in temperatures up to 2000°F. Kearfott Division of GPI and the Marquardt Corp. are contributing to the development. Both analog and digital prototypes will be tested soon, Martin says.

## ADVANCED MATERIALS

### CBS Lubrication Claims Annoy NASA

NASA scientists following the development of dry-film lubrication techniques are reportedly annoyed at some of the recent claims made by CBS Laboratories in Stamford, Conn. (M/R, Dec. 11, p. 28). Space agency officials feel that considerably more testing under a wide range of conditions—particularly high temperature and heavy radiation environments—is needed before any conclusions can be reached as to the overall effectiveness of the new CBS process.

### Thiokol May Build Big Booster Cases

Engineering teams from Thiokol's Wasatch Division have been eyeing a former Naval Ordnance plant at Pocatello, Idaho, for use in performing production operations on large metal and plastic components. The firm's proposed use falls into four categories—case preparation, warehouse operation, fabrication and rehabilitation of rocket component tooling, and fabrication of large rocket cases. The economy of the operation has yet to be established.

missiles and rockets, December 18, 1961

## PROPULSION

### Marquardt Tests Cold-Wall Rocket Motor

A 25-lb. high-efficiency rocket motor with cold outer walls, designed for satellite and space vehicle reaction control, has been successfully tested by Marquardt Corp. The unit was pulsed repeatedly, then subjected to 20-second, 60-second and 10-minute steady-state full-thrust runs. Outer-wall temperature leveled off below 200°F after one minute. Shut-down heat soak-back ran the temperature up to 240°F. The firm says the motor is capable of relatively unlimited operational life in both running modes.

### Micromotors Tested at Aerojet

Another satellite control motor using hypodermic needles for injectors is being fired at Aerojet's Azusa plant. The half-ounce unit generates between 0.1 and 0.01 pound thrust and is designed for day-long operation. The engine has been operated continuously for 30 minutes. Since the thrust is so low, the propellant lines can hold it to the satellite proper.

### Price Cut for Thermoelectric Materials

New production techniques developed by Alloys Unlimited Chemicals, Inc., will cut quantity prices of polycrystalline bismuth telluride and lead telluride by two-thirds, the company says. Widely used in thermoelectric devices, both are available in P- and N- types lead telluride in ½-in.-square ingots in 6-10-in. lengths, bismuth telluride ingots in 6-in. lengths and in diameters of 4, 7, and 14 mm. AUI says the new prices will be under \$50 a pound.

## ASTRONAUTICS

### Effects of Rocket Exhaust Under Study

Possible long-range modification of the upper atmosphere by exhaust gases and particulate matter from large rocket engines is under study by the Geophysics Corporation of America. The ARPA-sponsored investigation is designed to anticipate the atmospheric effects which may result from launchings of *Saturn* and *Nova* type vehicles.

## SUPPORT EQUIPMENT

### ComSats To Speak German

A ground station capable of handling up to 600 phone calls simultaneously will be built by the West German Post Office and is expected to be operational in late 1963 or early 1964. Construction of the ComSat station will get under way next spring near Munich. It will consist of four automatic tracking antennas, designed for operation with *Telesat* and *Relay* type satellites.

### Arnold Tests High-Altitude Chamber

Preliminary shakedown tests of the new high-altitude rocket-engine test chamber at the Air Force's Arnold Engineering Center have been highly successful, Center officials report. The 19-ft.-diameter test cell attained a simulated altitude of 365,000 ft.—corresponding to a pressure of less than  $3.2 \times 10^{-5}$  mm of Hg. AF officials describe the cell as the largest U.S. vacuum chamber available for testing chemical rockets and full-scale satellites and space vehicles under a simulated space environment.

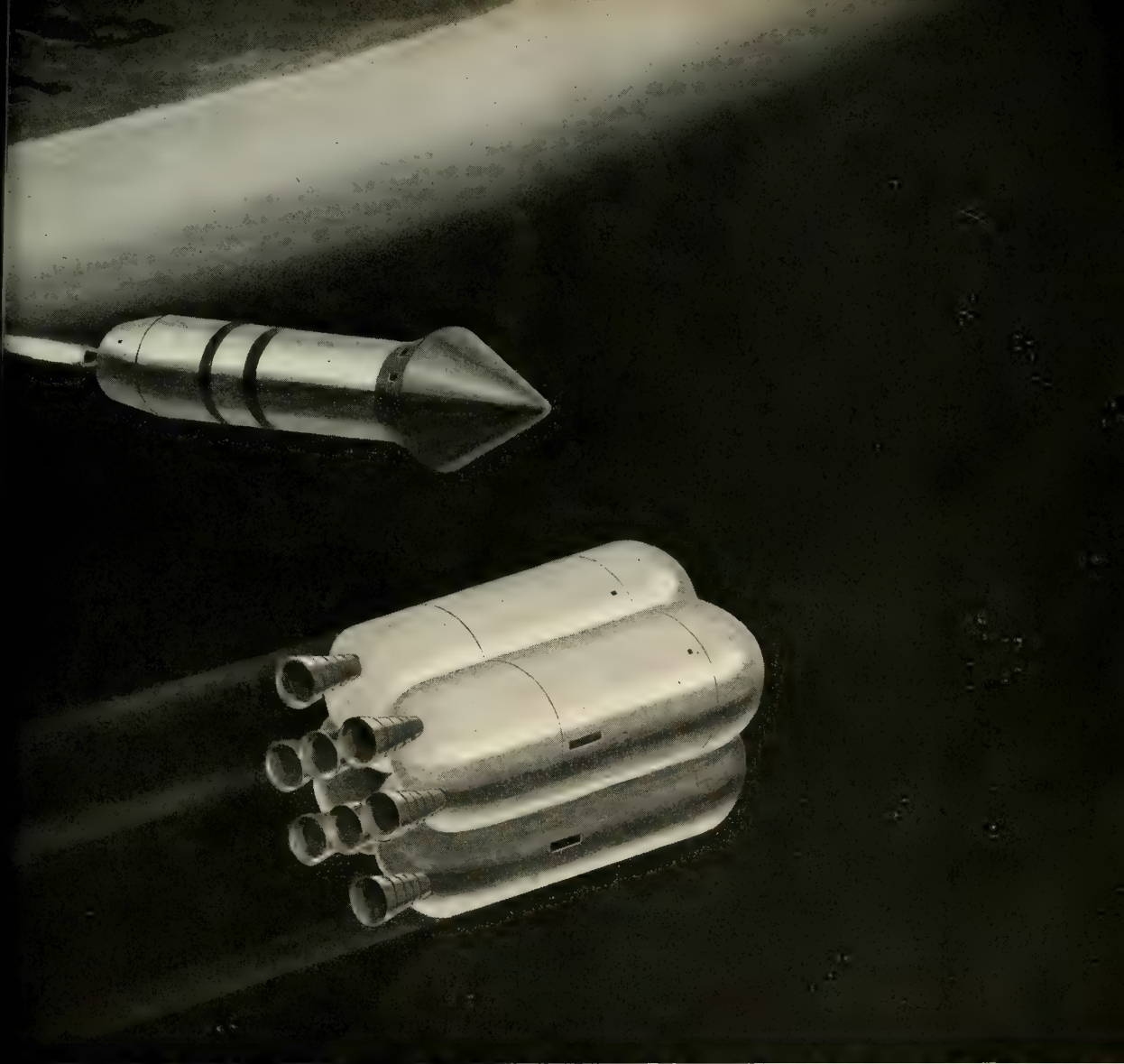


## ***Raytheon brings proven guidance and***

Three techniques are currently available to meet the challenge of Space Rendezvous Guidance: radar, infra-red and optics. Of these techniques, radar has been used for homing guidance systems to the greatest degree. Studies by Raytheon, whose radar experience spans three decades, have indicated that continuous wave radar possesses these desirable characteristics:

- No minimum or 'blind' ranges
- Greater range for a given weight
- Simple FM Techniques for ranging
- Direct and accurate velocity readings
- Ease of acquisition
- Greater simplicity and reliability





## ***sensor capability to space rendezvous***

The experience gained from the inertial guidance system for the advanced Polaris, coupled with the proven success of the Hawk and Sparrow C W homing systems give Raytheon the most extensive proven capability applicable to the space rendezvous guidance problem.

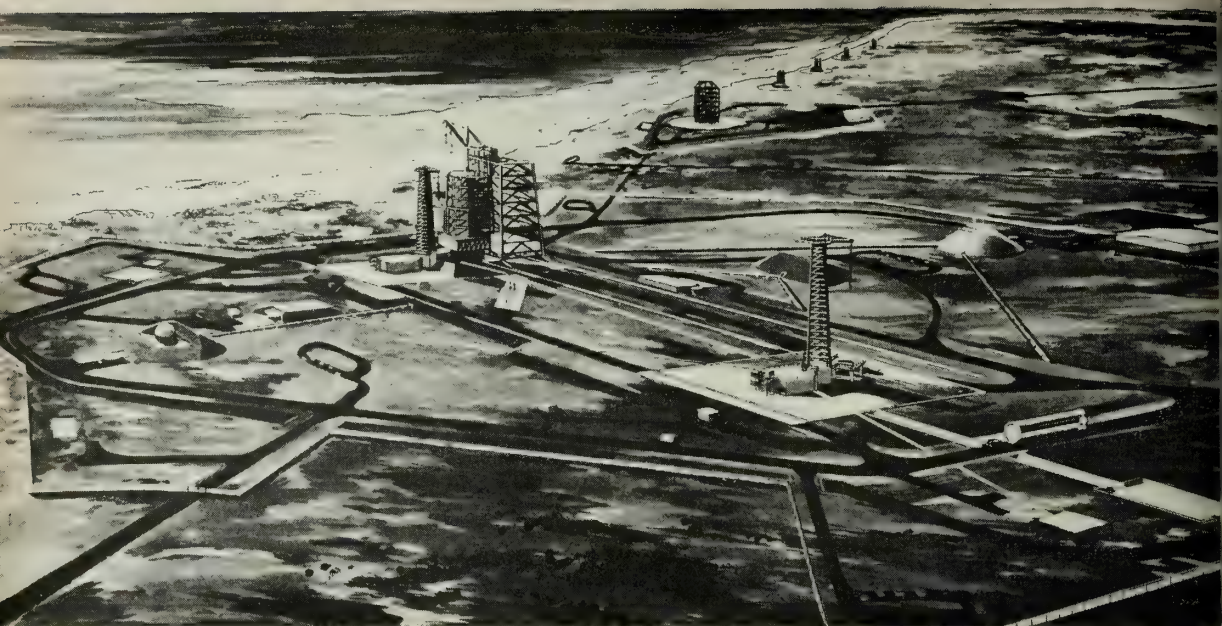
In addition, Raytheon, one of the world's largest scientific-industrial organizations, has proven its ability to manage every phase of a complex system — from early study and design through development, production and field support of operational systems and equipment.

*Missile and Space Division, Bedford, Massachusetts*

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LOOKING SOUTH from Complex 37, this drawing also shows Complex 34—the site of recent Saturn launch.

## space support

# Complex 37 Will Dwarf Predecessors

**Construction under way on launch site  
to be completed in time for '63 Saturn shots**

by Michael Getler

A HUGE NEW rocket launch site, double the size of any facility now in operation, is under construction at Cape Canaveral.

Officially called Vertical Launch Complex 37, the 120-acre tract at the north end of the Cape will be the launching scene for two-stage *Saturn* boosters by mid-1963.

Three major construction awards for about \$20 million have already been let for work on the first of two pads and some support systems. Another \$11 million has been approved by NASA for completion of the second pad. Award of this contract is expected in March.

Winner of the initial construction contract for Pad B was Blount Bros. Construction Co. of Montgomery, Ala. Blount has also been chosen to supply several of the supporting systems for both launch areas.

Pad B, now about 5% completed, will be ready by November, 1962, according to the Army Corps of Engineers, who are supervising design and

construction for NASA. Construction on Pad A, which will be a duplicate of the first site, should be completed by January, 1963.

Two Florida architectural and engineering firms were called in for assistance in designing the complex. Maurice H. Connell & Associates, Inc., of Miami, worked on the superstructure; Reynolds, Smith and Hills, of Jacksonville, on subsurface facilities.

Pads A and B at the complex will have individual automatic ground stations, launch pedestals, and umbilical towers. Structures common to both sites include a launch control center, or blockhouse; operations support building; propellant storage and transfer facilities; and a mobile, self-propelled service gantry riding on 1200 ft. of steel rails between the two launch stands. The massive 300-ft.-high gantry, extendable to 330 ft., is probably the largest movable structure in the world.

Here is a breakdown on available statistics for key elements at the launch complex:

- **AGC Buildings**—Two of these 50-ft.-wide by 122-ft.-long structures will be built directly beneath a portion of each umbilical tower. The buildings, which are unoccupied during launching, are multi-tiered, with three above-ground stories in the area under the umbilical tower, two stories exposed immediately adjacent to the tower, and a basement level running the length of the building. An ac/dc generator room is included within the AGC building, in addition to various instrumentation and checkout equipments for the booster vehicle. Electric power and high-pressure gas distribution equipment are also located here.

- **Umbilical towers**—Both are steel structures 268 ft. high, each on a 32-ft.-square base. These towers will be extendible to 320 ft. The maze of power, propellant, communication, and pre-launch check-out lines which wind through the tower to the missile created some problems in dynamic stability of the structure under heavy wind loadings. The extensive amount of con-

missiles and rockets, December 18, 1961



joints and piping created a tower surface nearly equivalent to a solid structure. To insure maximum stability, main tower columns and diagonals will be fabricated with 50,000-psi-yield steel, and special high-strength bolted joints will be used to damp severe oscillations.

- **Launch pedestals**—Both launch platforms at Complex 37 will be 47-ft.-sq. by 7 ft. deep, with a 12-sided cutout—32 ft. in diameter—in the center for vehicle engine exhaust. Triangular platforms will be mounted on top of the pedestal to enlarge the work area to a 55-ft.-sq. base.

The welded steel pedestals will be of box-beam type construction fabricated from 1, 1½, and 2-in. plates. An elevator and two staircases are included to provide ground access.

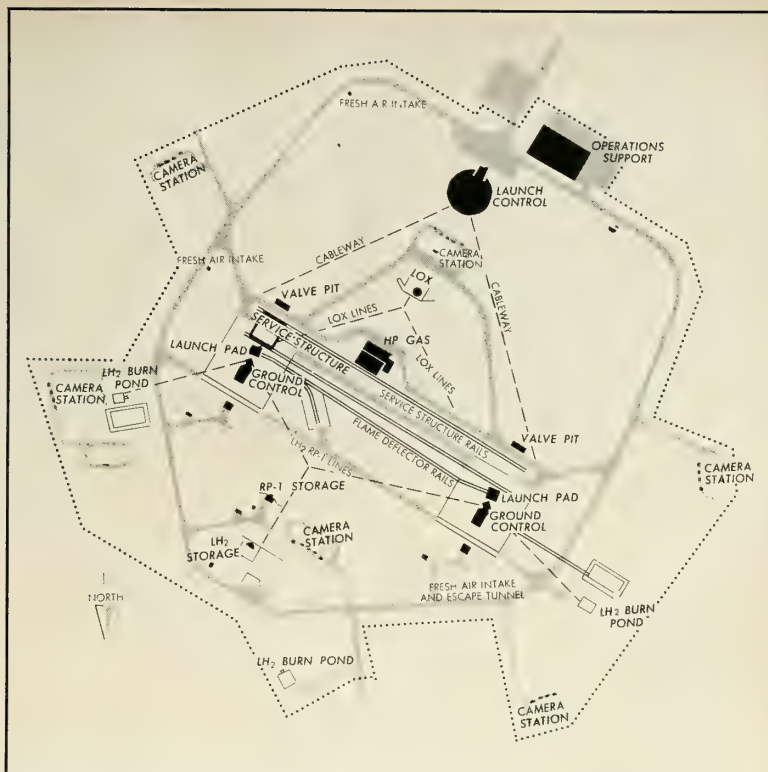
Initial fabrication, assembly, and checkout of the launch pedestal will be undertaken at the Todd Shipyard Corp. facilities in Houston, Texas. Todd and Blount Bros. are both involved in this phase of construction. Upon completion of the tests, the unit will be disassembled and shipped in quadrants to the Cape. Pedestal design was accomplished by a section of the Launch Operations Directorate at the Marshall Space Flight Center.

- **Blockhouse**—The launch control center interior measures 110 ft. in diameter and 37 ft. high. The blast-resistant dome is 12½ ft. thick, only slightly thicker than those employed in much smaller blockhouses. Just over 5 ft. of the dome thickness is reinforced concrete. The remainder is an earth fill. A total of 3290 cu. yds. of concrete and 400 tons of steel will go into dome construction. Main firing functions, tracking, observation, and test supervision will come from within this structure.

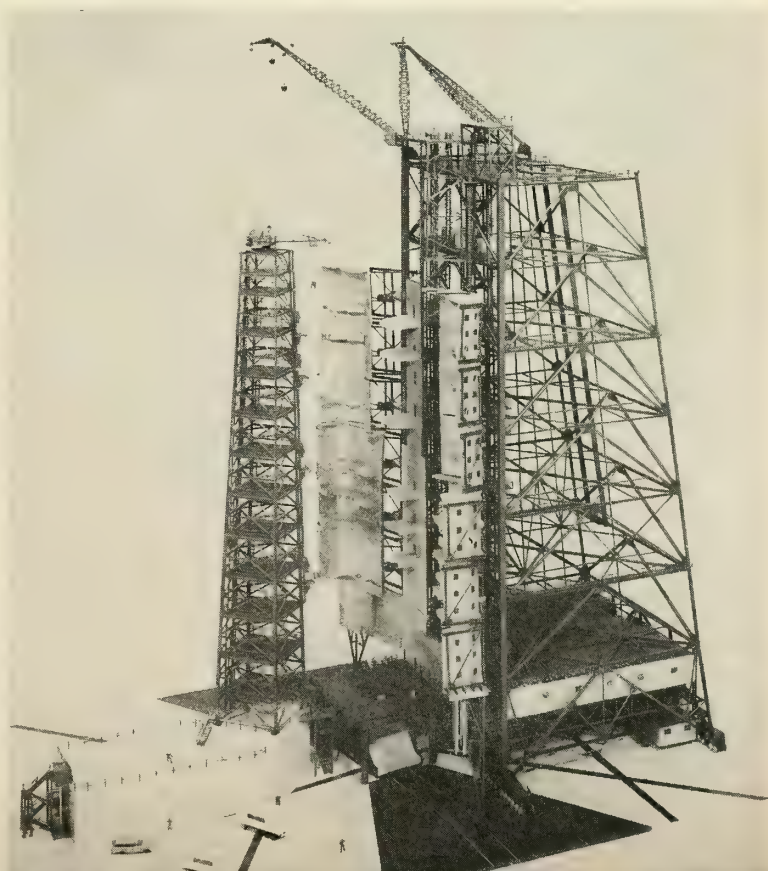
- **Storage and transfer**—Three separate propellant storage and transfer systems have so far been contracted for. The liquid oxygen system includes two tanks, one a 125,000-gal. storage unit and the other a 28,000-gal. vacuum-jacketed replenishing tank. A 43,500-gal. cylindrical steel tank will be installed to store the RP-1 kerosene fuel. Included in the high-pressure gas facility will be a storage battery with a 4000-cu. ft. water volume, a 35,000-gal. liquid nitrogen storage tank, a nitrogen vaporizer, liquid nitrogen pumps, helium compressors, and gas driers.

- **Service gantry**—Completely dominating the scene at Complex 37 will be the 7-million-lb. (basic weight) service gantry. Situated on a 120-ft.-square base, the gantry—including a derrick mast riding above the extended superstructure—will rise 375 ft. above the Cape. The derrick and 90-ft. boom

(Continued on page 47)



**ABOVE:** Layout of new launch area shows location of major structures and support systems. **BELOW:** Model of huge service gantry (right), umbilical tower (left) and launch pedestal (center). AGC building is shown at the base of the umbilical tower.



**A SINGLE  
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# Signals Intensify with Sunspots

VARIATIONS in solar activity appear to have a corresponding effect upon the reflectivity of radio waves transmitted to the sun from earth.

Increased radar echo intensities during periods of heavy solar radiation were recorded by a group of Lincoln Laboratory scientists working under a tri-service program to correlate solar phenomena with variations in radar reflectivity. The study may also lead to an improved early warning system against sunspot activity.

In the past, the most serious consequence of the solar action has been the disruption of earth communications.

However, with the advent of manned spacecraft the hazards of violent solar storms become more personal. Clouds of high-energy particles could be directly fatal or could cause disablement of all electronic systems aboard the vehicle.

Even for unmanned deep-space probes, the high cost of space hardware warrants an improved sunspot prediction capability.

The findings of the four scientists, reported in the December issue of the *Journal of Geophysical Research*, represent results of the first in a series of regular radar measurements of the sun's

corona made over an extended period of time.

Using a 500-kw, vhf transmitter, originally developed for ionospheric-scatter communications research, the Lincoln Lab team established radar contact with the sun on 32 days over an 11-week period from April 19 to July 7.

Sunspot activity during this period, the scientists said, was relatively low. Near the end of the test period, solar activity increased—with a corresponding increase in echo signal intensity.

## • High power, low antenna cost—

Field site of the space radar system used in the tests is near El Campo, Tex. The half-megawatt transmitter is believed the most powerful vhf radar in the world, a lab spokesman said.

A relatively economical array of 1024 individual dipole antennas is used for both transmitting and receiving. The array consists of eight rows of 128 antennas each. Each row is roughly 1700 ft. long; separation between rows is 15 ft. The antenna system produces a fan-shaped beam  $15^\circ$  wide (east-west direction) and  $0.75^\circ$  thick. Operating frequency is nominally 38.25 mc.

Signals are transmitted continuously for 16 minutes—about the time required for a signal to make the complete trip to and from the sun. To assist signal discrimination against cosmic noise and solar radiations, frequency stepping is employed in increments of 8 kc at 8-sec. intervals. An irregular but carefully controlled switching pattern is employed to assist in signal identification.

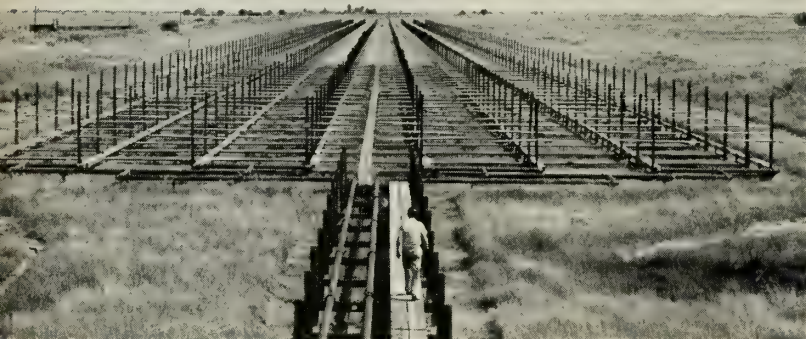
Frequency stepping is used instead of conventional radar pulsing, the scientists said, to permit continuous transmission and, thus, obtain the highest possible average power.

## • Tailored beam pattern—

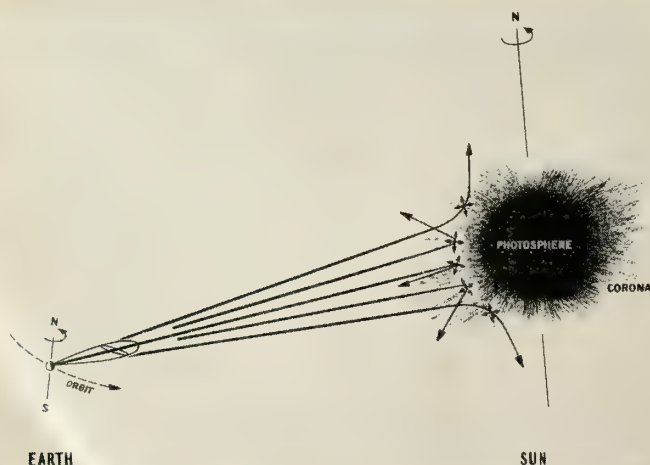
Antenna aiming is accomplished electrically by adjustments on the connections to each dipole.

The photosphere (or visible solar disk) subtends an angle of about  $0.5^\circ$ , when viewed from the earth. During the 16-minute transmitting period, the sun's path covers half of the  $15^\circ$  beam width. Thus, the sun is visible to the radar for the full operating time without the need for reorienting the antenna array.

Beam thickness is just enough to permit observations of the solar disk and the surrounding corona. ■



DIPOLE ANTENNA ARRAY at El Campo, Tex., for Lincoln Laboratory's vhf space-radar system, is made up of 1024 dipoles driven by 500,000-watt transmitter.



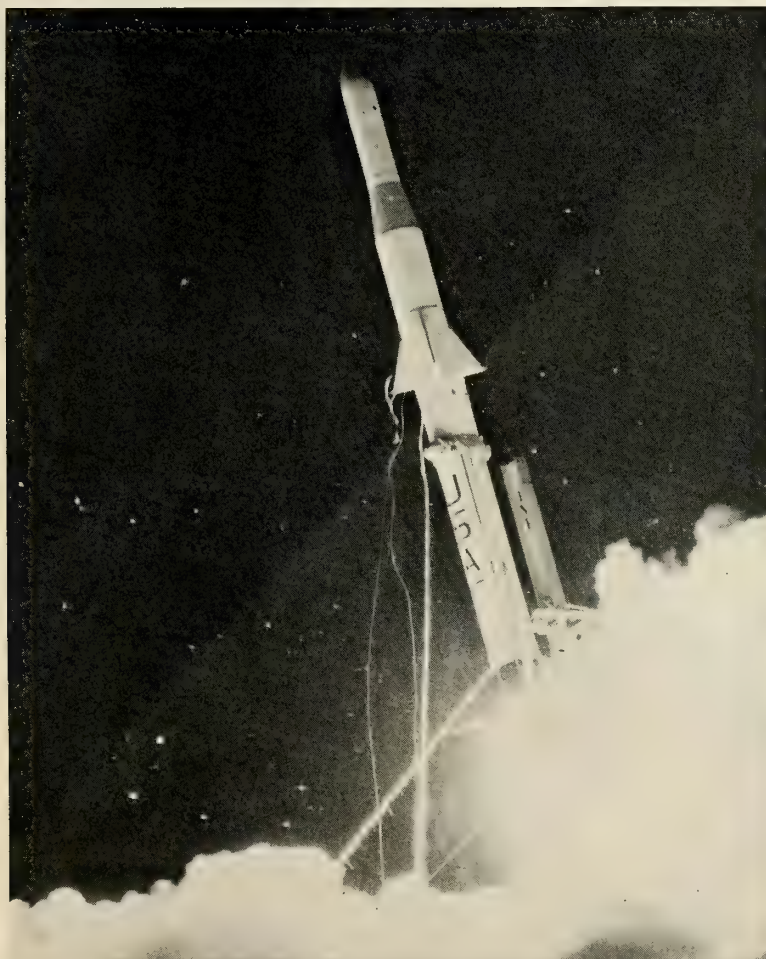
DRAWING ILLUSTRATES irregular reflection of radar signals from solar corona, nearly 93,000,000 miles from earth. Signals' round trip takes 16 minutes.



# 'Digilock' System Passes First Flight Test

*Low-power telemetry package by Space-General closely approaches theoretical maximum communication efficiency*

by Arthur H. Collins



AIR FORCE Blue Scout Jr. blasts off from Pt. Arguello on Dec. 4 in successful first flight test of Space-General Corp.'s Digilock low-power telemetry system.

missiles and rockets, December 18, 1961

THE AIR FORCE has successfully flight-tested a low-power telemetry system intended to transmit data over long distances in space.

Employing only 0.25-watt transmitted power, the first Digilock system developed for the Air Force Systems Command's Special Weapons Center by Space-General Corp. was flown Dec. 4. The telemetry package was aboard a *Blue Scout Jr.* payload lofted to an altitude of about 27,000 miles from Point Arguello, Calif.

The payload, designed to measure solar-originating low-energy protons, originally was to have carried a second telemetry system—an FM/FM subsystem for vehicle performance data—but this was eliminated to allow the addition of more scientific instrumentation.

The Digilock used in a second subsystem employed a specially encoded PCM technique.

• **Orthogonal**—Dominant in the Space-General system are the Digilock codes—derived from Reed-Muller orthogonal codes. These consist of a number of different binary sequences, with each sequence representing digital input data of a different value.

As used in the AFSWC payload, 32 values of Digilock input data were represented by 32 code-sequences with each sequence containing 16 bits. Because the 32 values of input data constitutes 5 bits of information, a 16-bit Digilock code contains 11 bits of redundancy. The redundancy is used in such a way as to make the codes orthogonal.

The combined ground-based receiver and decoding unit contains matched filters for each of the codes. Due to the orthogonality of the codes, the matched filter corresponding to the transmitted code will, in the absence of noise, deliver an output—while the outputs of all the other matcher filters are zero.

A solid-state commutator in the missile-borne Digilock unit selects the scientific data from one of 20 experiments. A 5-bit binary word is selected in accordance with initiation pulses obtained from the Digilock code generator. The selected word is fed into the data input of the code generator.

The code generator output consists of a 16-bit Digilock sequence which corresponds to the value of the input data. The output is used to bi-phase-modulate the telemetry transmitter by  $\pm 60^\circ$ . Transmitter output, therefore, can be resolved into an unmodulated carrier plus a constant amplitude rf





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He has plans for an orbital launch facility (picture, top left) to help them get there in the first place. Inside, in a shirt-sleeve environment (top, right), a space vehicle can be prepared for launch to the moon itself. On the moon (center), connected structures above and below the surface are required for the Advanced Habitation Engineering needed to support a permanent lunar base. Lunar traverser (bottom) is used to move men and materials and assist in construction of a permanent base.

Already, AMF has designs and concepts which make those pictured obsolete. As new knowledge becomes available, AMF quickly incorporates it into simpler, more reliable, more easily fabricated mechanisms.

AMF has completed and is now carrying on studies and feasibility investigations covering a wide range of space environment problems in conjunction with space vehicle manufacturers and for several government departments. Space environment, itself, is just one of a virtually complete spectrum of AMF defense capabilities.

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signal that either leads or lags the unmodulated carrier by 90°, depending upon the instantaneous value of the code-generator output.

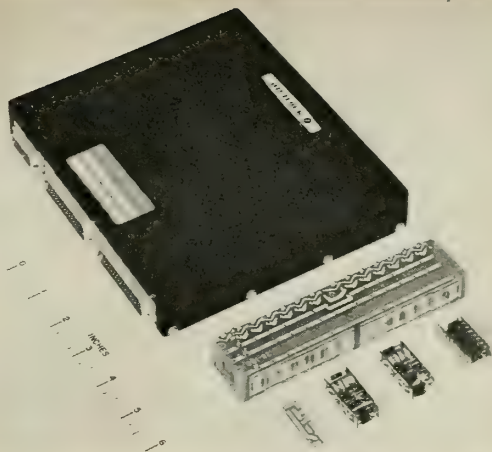
A phase-locked receiver at the ground-based receiving station locks to the unmodulated carrier component of the Digilock transmission. The Digilock sequences appear as binary voltages at the output of the receiver phase detector, since loop bandwidth of the phase-locked receiver is too narrow to follow the modulated component of the transmission.

These voltages are recorded in analog form on one channel of a tape recorder. On a second channel, a time-of-day signal from ground equipment is recorded. A clock signal is recorded on a third channel at a frequency which is an integral multiple of the Digilock bit-rate, and is ultimately used to trigger the analog-to-digital converter in the data reduction system.

• **Playing back**—In the AFSWC system, the recorder tape is shipped to a data reduction center in Albuquerque, N.M., and played back with the receiver video-signal being "integrated and dumped" in accordance with the clock signal from the tape's second channel. The output of the I-and-D circuit is sampled by an analog-to-digital converter just before the dumping and again in accordance with the recorded clock signal. Thus the analog-to-digital converter yields 14 consecutive digital samples for each Digilock bit received.

An IBM data processing computer is used to determine bit-sync from the received data by effectively time-shifting the data through a decoding matrix and noting when the decoder output is maximized. The computer cannot determine the initiation time of a Digilock bit with an accuracy much better than the intersample time. Therefore, it is desirable to have a fairly large number of samples per Digilock bit. The rate of 14 samples per Digilock appears satisfactory, says Space-General.

Digitized samples of the received signal are then recorded on tape in IBM format together with the time-of-day signal. IBM data processing is accomplished by two separate tape run-throughs. The first run determines bit and word-sync for the received data;



*SOLID-STATE COMMUTATOR in missile-borne Digilock selects scientific data from one of 20 experiments.*

the second takes advantage of this information to decode the Digilock sequences and determine the transmitted scientific data.

• **Surplus weight**—The entire Digilock encoder is made up of transistorized sub-miniature modules connected and potted in epoxy to form a stick package. Eight sticks were used in the AFSWC package, with the whole unit packaged in a metal case to meet AFSWC requirements.

Space-General, however, believes a much lighter case could be used for most applications. The present package weighs 4.7 lbs., including the 100-wire input cable harness, and has a volume of only 70 cu. in. The Digilock encoder, developers say, requires 112 ma from an unregulated 7.5 v dc source, and 47 ma from an unregulated-6 v dc source. Power consumption is 1.12 watts.

The overall telemetry system for the AFSWC package was designed to meet the specific requirements that vehicle performance data be made available to ground stations with a minimum of processing delay. In contrast, scientific data handled by the Digilock system were not required to be processed with any special rapidity.

The Digilock system has a communication efficiency closely approaching the maximum achievable value predicted by information theory (Shannon theoretical limit).

System versatility enables any number of analog and/or digital inputs to be used, and a wide range of data rates are available. Since the size of the transmitter selected is the only range limitation, the system is particularly suitable for deep-space probe vehicles, orbiting satellites and extended-range ballistic weapons.

✻

## 'Ardeforming' of Big Solid Cases

**Maine firm uses cryogenic process to stretch-form a 30-in.-dia. chamber—any size, shape seen feasible**

by John F. Judge

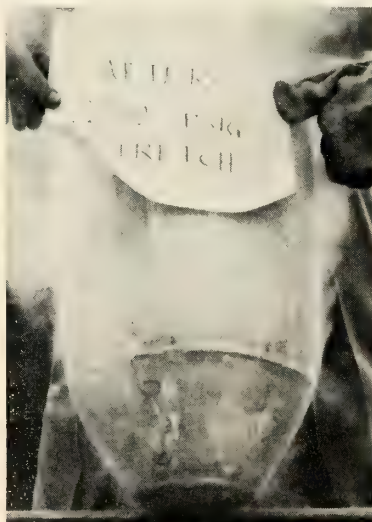
THE SUCCESSFUL cryogenic stretch-forming of a 30-in.-diameter chamber by engineers at Arde-Portland, Inc., is the first step towards proving the application of the method to large solid-rocket booster cases.

The experimental chamber was stretched at 1500 psig with an increase in diameter of 11.7%. Nominal ultimate strength is 245,000 psi and yield is 225,000 psi.

The cryogenic metalworking process, Ardeform, takes advantage of the property of austenitic materials which can be cryogenically worked to a material of high strength and good ductility.

The process (M/R, Aug. 28, p. 32) takes place in a bath of liquid nitrogen at  $-320^{\circ}\text{F}$  and transforms the austenite to ferrite to produce the improved material. Since all welds are worked simultaneously with the base metal,

**LEFT:** The roll and welded truncated closure shown here before cryogenic forming illustrates the relative simplicity of the initial fabrication process involved in Ardeforming.



**ABOVE:** After cryogenic work-out, the closure is expanded to a smoothly curved structure, eliminating the line-construction and strengthening the welds. Weld strength matches that of base metal.

weld strength is increased to that of the base metal.

Ardeforming eliminates the need for heat-treating, together with the necessity for expensive straightening and rounding-up of the vessel after quench.

In the 30-in.-diameter chamber series, all four have roll and weld center sections; two use welded composite heads and two employ spun domes. The current test chamber is AISI Type 301 stainless steel.

• **Correlations good** — Arde-Portland burst one vessel (at  $-320^{\circ}\text{F}$ ) which stretched 22% before failure. It was not a 30-in. chamber. The true stress at failure of this vessel, based on wall thickness at failure was 385,000 psi. All welds were butt-welds and no beefed-up joints were involved. These test chamber results coincided very closely with the theoretical strain limits predicted from uniaxial tensile coupon data.

No chamber cryogenically stretched 13% has yet failed ambient temperature hydrotest. In addition, every chamber tested to failure tears in a characteristic way. There is no shattering. The edges of the ear run along a  $45^{\circ}$  cleavage plane in every case. The chambers remain in one piece, demonstrating their ductility.

Actually, all the conditions of a standard hydrotest are present in the stretch-forming operation. The main difference is the temperature.

Ardeforming permits extremely close volume control; exact uniformity is maintained from chamber to chamber. A-P engineers can give a customer any volume desired — independent of shape.

The firm does not have forming pits large enough to handle the big solid boosters currently being investigated by the propulsion industry. However, Arde-Portland engineers see no technical barrier to applying cryogenic forming methods to vessels of any size.

Transportation is no great problem — the forming facility at South Portland, Me., is right on the ocean. The firm is giving some thought to using nearby abandoned stone quarries for large cases.



# n Offing

Analyses have shown no hazard problems in the process. A blast mat, originally placed over the present forming pits has been found to be unnecessary.

Some of the country's largest machine and handling equipment is located next door to Arde-Portland. Although these are not a part of the firm, spokesmen say arrangements can easily be made.

- **Expanded effort**—Other shapes are under active investigation. Spheres have been stretch-formed without dies, with close dimensional tolerances maintained. Other chambers have been stretched to provide data on the forming of a large-diameter boss in a spherical end closure.

A study of the stretching of elliptical and other non-spherical end closures is under way. Since heads and cylinders are geometrically different, different stretch rates are encountered. Investigations already indicate that materials of different ductility can be used to expand the junction of the cylinder and the heads to a vessel of perfect geo-



*ALL ARDEFORMED STRUCTURES burst with this characteristic result—a long tear without shattering and a 45° taper on the failure edges.*

metrical configuration.

Arde-Portland is also involved in basic metallurgical work on the effect of composition of austenitic stainless steel on the ambient temperature strength attained through cryogenic stretching. Although sufficient data has not yet been collected, Arde experts say an optimum stability level appears to exist. Stability is a measure of the tendency of the austenite to transform.

Unstable materials apparently do not retain sufficient austenite at  $-320^{\circ}\text{F}$  to allow desirable strain-induced transformations. Too-stable materials do not adequately respond to the cryogenic strain.

Arde has performed innumerable

cost analyses on the process. The firm says its process has an economic edge on conventional case fabrication methods. In the big-boost area, a 14-ft.-diameter case could be handled in nine manufacturing steps, as against the 16 or more required by conventional methods.

The main initial cost would be in constructing the facility for larger boosters. Segmented cases can be handled, but the unit must be a closed cylinder for the forming operation. Two extra cutting operations must be made to remove the closures. Arde-Portland experts say this would still be cheaper than a comparable segment fabricated conventionally. **✻**



*PREFORM FOR 30-IN. CHAMBER is conventionally fabricated from Type 301 stainless steel without reinforced weld areas. Center cylinder is roll-welded.*



*AFTER ARDEFORMING OPERATION, chamber was ultimately stretched to 11.7% increase in diameter. Chamber illustrated was interrupted after 1400 psig stretching.*



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# 9 December 1961

A prototype of a huge booster-size, segmented, solid propellant rocket motor was successfully test fired by the U.S. Air Force. The test was conducted for the Air Force by United Technology Corporation at the firm's Development Center near Morgan Hill, California. The giant rocket motor, which was designed and built by UTC, produced nearly a half million pounds of thrust.



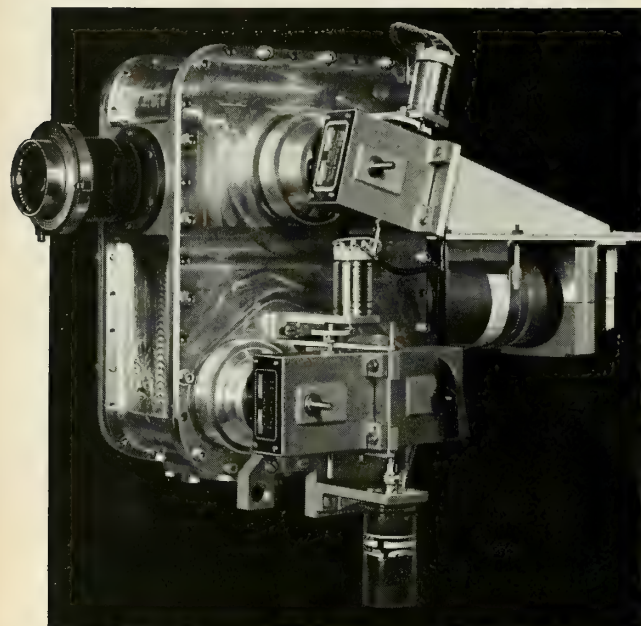
**United Technology Corporation**

P. O. Box 358, Sunnyvale, California

SUBSIDIARY OF UNITED AIRCRAFT CORPORATION

# PHOTO-DIELECTRIC TAPE CAMERA SYSTEM

... a major advance in space image-sensing



The development of photo-dielectric tape permits the design of a totally new image-sensing system for utilization in satellites and space vehicles. A prototype camera for use with this tape has already been operated and tested. This system, one of the first developed primarily for use in space, offers a number of advantages over existing photographic and television techniques.

Operating on the principle of storing an optical image by converting it to an electronic charge pattern, the photo-dielectric system has inherently high resolution since the picture charge pattern is read out directly as a video signal by an electron beam. Moreover, it offers real promise of providing response in various parts of the radiation spectrum in addition to the visible including infrared and ultraviolet with sensitivity better than standard photographic techniques.

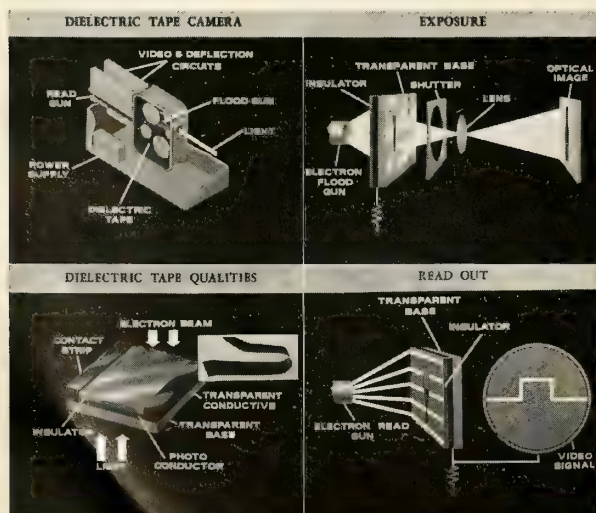
Readout is accomplished by use of a finely focused electron beam which scans the charge pattern. It is then converted directly to a video signal for transmission to the ground. Readout can be accomplished at different speeds to compensate for various power and band-width requirements dictated by the nature of the space mission.

The flexibility of the system permits readout of the same image numerous times, if desired, by ground control. In the laboratory, the same image has been read out up to 100 times without serious degradation of quality. Yet, the image is erased completely, with no trace of "sticking," as the tape is flooded with electrons prior to exposure. Transistorization of the package results in minimum weight and low power requirements.

Since a high vacuum is essential to the operation of a photo-dielectric tape camera system, it is "at home" in the harsh environment of space. Also, dielectric tape is virtually unaffected by radiation thereby eliminating this hazard to ordinary photographic film. It is also reusable and serves as its own storage medium for remote picture-taking sequences.

To find out how RCA's new photo-dielectric tape camera developments can fill your requirements for space image-sensing systems, write to the Manager, Marketing, Astro-Electronics Division, Defense Electronic Products, Radio Corporation of America, Princeton, New Jersey.

And for a challenging, rewarding career in electro-optical systems development, apply to the Employment Manager, RCA Space Center, Princeton, New Jersey. All qualified candidates are considered regardless of race, creed, color or national origin.



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# Big GE Solar Power System Tested

THE LARGEST solar thermionic power system reported in the U.S. is functioning in a new General Electric Co. solar test facility outside of Phoenix, Ariz.

The unit has a potential efficiency of 15 to 20% of the total solar energy input. Early tests resulted in an output of 12.18 watts, but indicated design improvement areas. GE engineers believe a system can be designed which will produce as much as a kilowatt for each 100 lbs. of weight.

The system has no moving parts. An ideal solar thermionic unit would have this advantage plus light weight and more efficiency than other direct conversion power systems, such as thermoelectric devices.

Main parts of the system include a 195-sq.-ft. solar collector measuring 15.75 ft. across. The collector folds into a 12-ft.-dia. package when its petals are compacted. The decahedron generator has 105 thermionic vacuum converters and a switching system for light and dark periods.

The overall system includes a solar orientation unit, a power regulator which maintains output voltages between 26 and 29 volts, and a storage system consisting of a nickel-cadmium battery with 23 cells.

The vacuum thermionic converters are capable of 1.5 watts at 2.65% efficiency. More efficient converters using cesium vapors have been developed and may be used in future tests.

The more advanced vapor types may give as high as 25% efficiency. The current barium-strontium oxide-coated converters were built by GE. Temperatures up to 1150°C with an average of 904°C were achieved on the cathode during operation.

The system is designed for use in manned spacecraft, lunar colonies and communication satellites.

• **New test site**—The new GE solar thermionic power package was the first device to undergo tests at the company's recently completed solar test facility.

The main test building is 61 ft. long, 34 ft. wide, and 36 ft. high. A 41-ft. section of this building is mounted on 80 ft. of steel rails and is mobile and self-propelled, to permit rapid exposure of the solar mirror and associated equipment to the sun.

The two-axis tracking platform con-



*SOLAR COLLECTOR in GE's system is 15.75 feet in diameter, folding into 12-ft.-dia. package. Decahedron generator has 105 thermionic vacuum converters.*

tained in the main test area can support loads up to 30,000 ft.-lbs., and is controlled to within 3 minutes of arc by a solar-sensing network. A manual override control is also available.

Supporting the main test area are a 400-sq.-ft. control and auxiliary equipment area and a complete weather station to determine test input parameters.

• **EHD device**—GE scientists in Philadelphia also announced successful testing of a device which produces electrical power using "electrohydrodynamics." A net output of 1.4 milliwatts at 170 volts with an input of only 0.1 milliwatts was achieved.

In an experimental generator, air was forced through a corona discharge

field and ionized. As a result, electrons were drawn off in the area of the field, while ions were pushed downstream by neutral atoms to a collecting grid where they were re-combined with the electrons. The flow of electrons from the corona through a circuit to a collecting grid constitutes an electric current.

A small amount of power was supplied to the corona ring as exciter. The experiments showed that as the velocity of the air increased—causing more electricity to be generated—the amount of externally-supplied electricity became replaced.

GE spokesmen say the art in EHD is too elementary to predict ultimate advantages and limitations. ♦♦

## Ford-Philco Merger Wins Final Approval

THE FORD Motor Co. last week acquired the Philco Corp., strengthening Ford's bid for a larger slice of missile/space business.

Philco will retain its own name and will operate as a subsidiary of Ford, within the general products group.

It will be headed by Charles E. Beck, Ford's former director of business planning, who said the acquisition "puts Ford in a position to do a better job in the Government contract area." But Beck said there are no plans at present to merge the Aeronutronic division with Philco.

Earlier this year, (M/R, Sept. 25, p. 17) Ford President John Dykstra said his company is "moving into the defense and space business with both feet. We are determined to be in the vanguard of our country's effort to regain Space Age leadership."

**CONTROL DATA CORP.** opened a West Coast Computer Applications Center at Palo Alto, Calif., to provide computer time, contract programming and maintenance services for Control Data equipment.

**INFRARED INDUSTRIES, INC.** has formed a new unit to design satellite payloads capable of withstanding Van Allen Belt radiation. Electro-Nuclear Laboratories, Inc., will engage in radiation research using a 2-million-electron-volt particle accelerator. ENL headquarters will be at Mountain View, Calif.

**COLLINS RADIO** broke ground for an addition to its Components Division, Santa Ana, Calif. The expansion will double the size of the present facility.

**GULTON INDUSTRIES, INC.**, has acquired Rustak Instrument Co., Inc., Manchester, N.H., and Continental Wire Corp., Wallingford, Conn. Rustak makes recording and indicating instruments used in industrial controls, medical, military and other fields.

Continental will soon begin production of small high-temperature, low-noise coaxial cables for the missile industry.

**GOODYEAR AIRCRAFT CORP.** established a new space systems engineering division to handle design of manned and unmanned space, re-entry and launch vehicles and their support equipment.

The company also created an aeromechanics technology division for development of space materials, including those for expandable structures, aerodynamics, thermodynamics, structural stress analysis, structural dynamics and weight control, along with test operations and instrumentation.

An advanced technology division has been set up to handle all advanced weapon system design, including tactical missiles and underseas warfare studies. A life science group will study basic space vehicle environmental problems.

**AIR PRODUCTS AND CHEMICALS, INC.** has opened a new oxygen-nitrogen production facility in Cleveland. The plant will produce some 600 tons per day of liquid and gaseous oxygen, nitrogen, argon and neon.

**AMERICAN MACHINE AND FOUNDRY CO.** opened a new environmental laboratory at Stamford, Conn. The facility will operate as a part of the Greenwich Engineering Division of AMF's Government Products Group.

The lab is being used to test components for *Minuteman* storage, erection and launching mechanisms. It will also be available for other AMF programs and for outside companies which require performance of a variety of environmental tests.

**THE HALLICRAFTERS CO.** acquired Manson Laboratories, Inc., Stamford, Conn. Manson sales are mainly in military contracts. The company provides electronic R&D in the fields of military communications and high-power equipment.

**UNITED AIRCRAFT CORP.** is opening a systems center at Windsor Locks, Conn., to develop, manage and produce complex space, missile and other military systems. The Center will work with missile and space organizations other than United's divisions, as well as acting as the parent company's systems organization.

United also established a Solid Rocket Division in California to provide a framework for volume production of solid-propellant rocket motors. The division will support the activity of United Technology Corp.

**AERO-FLOW DYNAMICS, INC.** is the new name for Aero Supply Mfg. Co., Inc., Corry, Pa. and Linden, N.J.

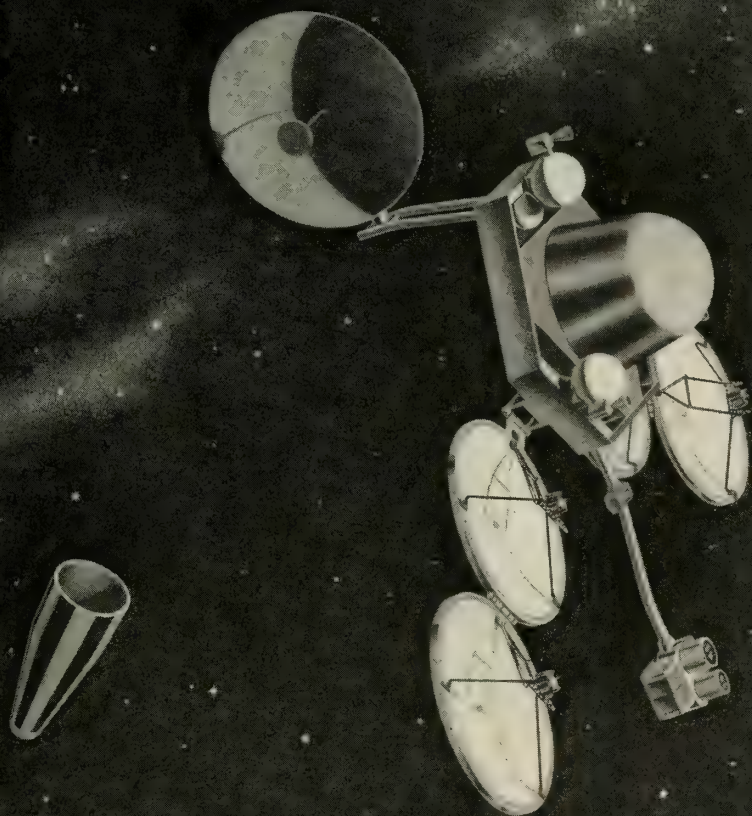
**ETS-HOKIN & GALVAN, INC.** formed a West Coast subsidiary, the Technical Construction Co. TECON will be principally engaged in mechanical construction and installation projects at missile bases, other military sites and factories.

**DAMON ENGINEERING, INC.** has been formed in Needham Heights, Mass. The electronics company will produce quartz crystal filters, oscillators and other frequency selection and control systems and custom-built systems for spectrum analysis and telemetry.

## Financial Reports

| COMPANY                        | PERIOD         | INCOME       |              | EARNINGS   |            |
|--------------------------------|----------------|--------------|--------------|------------|------------|
|                                |                | 1961         | 1960         | 1961       | 1960       |
| Bowmar Instrument Corp.        | Year, Sept. 30 | \$ 6,417,391 | \$ 5,411,822 | \$ 386,785 | \$ 323,664 |
| General Precision Equip. Corp. | 9 Mo. Sept. 30 | 171,196,090  | 176,554,550  | 4,189,000  | 3,622,000  |
| Litton Industries, Inc.        | 3 Mo. Oct. 31  | 73,000,000   | 52,111,000   | 3,425,000  | 2,150,000  |
| Marquardt, Corp.               | 40 Wks. Oct. 8 | 35,021,350   | 51,139,377   | 464,776    | 1,088,203  |
| Microdot Inc.                  | Year, Sept. 30 | 5,296,485    | 2,976,800    | 297,617    | 153,786    |
| Moog Servocontrols Inc.        | 3 Mo. Sept. 30 | 2,564,688    | 1,880,485    | 29,075     | —131,223   |
| Northrop Corp.                 | 3 Mo. Oct. 29  | 74,541,000   | 62,028,000   | 2,033,000  | 2,042,000  |
| Radiation Inc.                 | Year, Aug. 25  | 26,244,383   | 23,155,845   | 587,839    | 184,787    |
| Servomechanisms, Inc.          | 9 Mo. Sept. 30 | 9,358,000    | 10,196,000   | 357,000    | —771,000   |
| Sperry Rand Corp.              | 6 Mo. Sept. 30 | 547,133,965  | 561,352,778  | 9,695,026  | 11,774,666 |
| Varian Associates              | Year, Sept. 30 | 57,987,817   | 46,482,031   | 2,803,866  | 2,861,886  |





## AUXILIARY POWER SUPPLY

Direct conversion of heat to electricity offers the solution to the problems of auxiliary power in space.

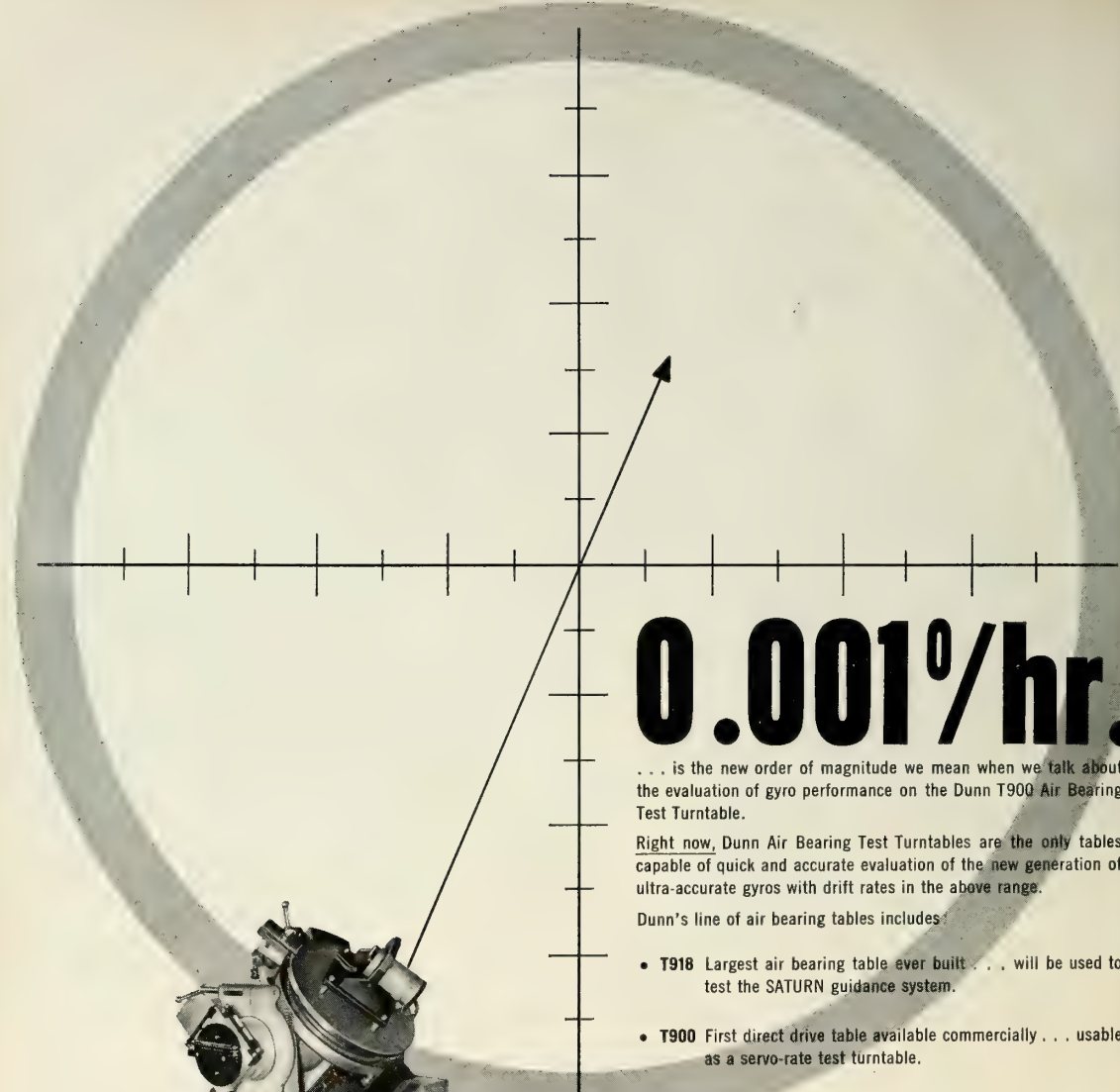
New techniques of space charge neutralization are being developed at Ford Instrument Company under U.S. Air Force, U.S. Navy and company sponsored studies. This work offers the opportunity to obtain significant power densities with wide spaced plasma power diodes at cathode temperatures around 1200°C. Application studies currently being undertaken involve chemical, solar and nuclear heat sources. i.e.



**FORD INSTRUMENT CO.**  
DIVISION OF SPERRY RAND CORPORATION  
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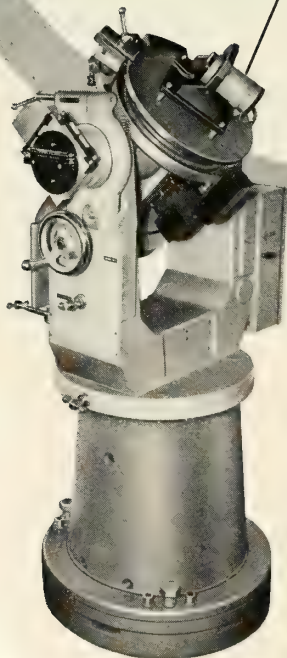
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*If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Mail Zone 130-90, General Dynamics | Astronautics, 5709 Kearny Villa Road, San Diego 12, California.*



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**MECHANICAL DESIGN:** BSME or AE for pneumatics, hydraulics, and fluid systems design and test. Also missile GSE and missile structures designers.

**RELIABILITY ENGINEERING:** Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics; higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

**ENGINEERING WRITERS** with 2 years of college and 3 years of experience in preparation of TCTO's; operations, maintenance, and overhaul manuals.

**SYSTEMS ENGINEERING:** BS degree required, advanced degree desired, in engineering or related field. Two to five years of experience, including missile or similar background in testing, methods of operation, systems analysis, and evaluation. Assignments will include establishment of test requirements, determination of factory tolerance structures, and evaluation of field testing.

**GUIDANCE SYSTEM ANALYSTS** to define the optimum characteristics, philosophy, and mode of operation of sophisticated guidance systems of extreme accuracy. A PhD degree plus experience in guidance systems and missile simulation is desired, but more extensive experience in related fields will be favorably considered.

**PRE-DESIGN ENGINEERS** with experience in proposal preparation and system design of guidance and tracking systems.

If you desire to become part of this great team, we urge your prompt inquiry on the attached Professional Placement Inquiry.

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# Cape Complex 37

(Continued from page 25)

which top the gantry have hook capacities of 10, 40, and 60 tons for assembly of booster stages.

Two gantry support buildings, one of 12,500 sq. ft. and another of 2500 sq. ft., are built into the structure and move with it. These house support shops, hoisting units, and electrical control systems. Side panels of these buildings are of blowout design as protection against blast from adjacent areas.

Fixed platform levels and adjustable service platforms enable convenient assembly of the vehicle. All levels are served by two high-speed elevators.

Aluminum and 100,000-psi steel are the predominant materials in the basic gantry structure and the hinged vehicle enclosures.

The service gantry, which can move along standard-gauge steel rails at speeds up to 40 fpm or as slow as 1½ fpm, is powered by variable speed ac drives which supply traction to 32 of the 48 3-ft.-diameter wheels. A 1000-kva substation aboard the gantry supplies electrical power needs.

When the movable gantry is at its operational position alongside the launch site, the load is removed from the wheels by hydraulic equalizer rams and the structure is lowered to the foundation anchor assemblies and locked in place. The process is reversed prior to moving the service structure; the entire unit is lifted about 3 in. from the ground, and load is reapplied to the wheels.

• **Design problems**—The physical location of the new vertical launch facility at the Cape presented several early engineering problems, according to the consulting architectural and engineering firms.

The north end of the Canaveral complex has considerable marsh land which meant extensive site preparation. Soil in the immediate vicinity of the service structure anchors, launch control center, and pedestal was predominantly medium to fine sand which had to be consolidated to near-maximum density to withstand the anticipated severe vibrations of missile launch. A vibro-floatation method was used for this earth compacting job.

Heavy electrical load requirements for the new complex also demanded extension of transmission lines from southern portions of the Cape and installation of a new substation.

Also, the large volume of water necessary for fire protection required the construction of a 1 million gal. storage reservoir and pumping network (30,000 gpm). **\*\***

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ISSUES OF JULY 3, 1961 THROUGH DECEMBER 18, 1961

*At the end of each six-month period, MISSILES AND ROCKETS publishes an easy-to-find listing of major news and technical articles carried by the magazine. Note that because M/R publishes 51 times a year, every week except the last week in December, the current index covers 25 issues.*

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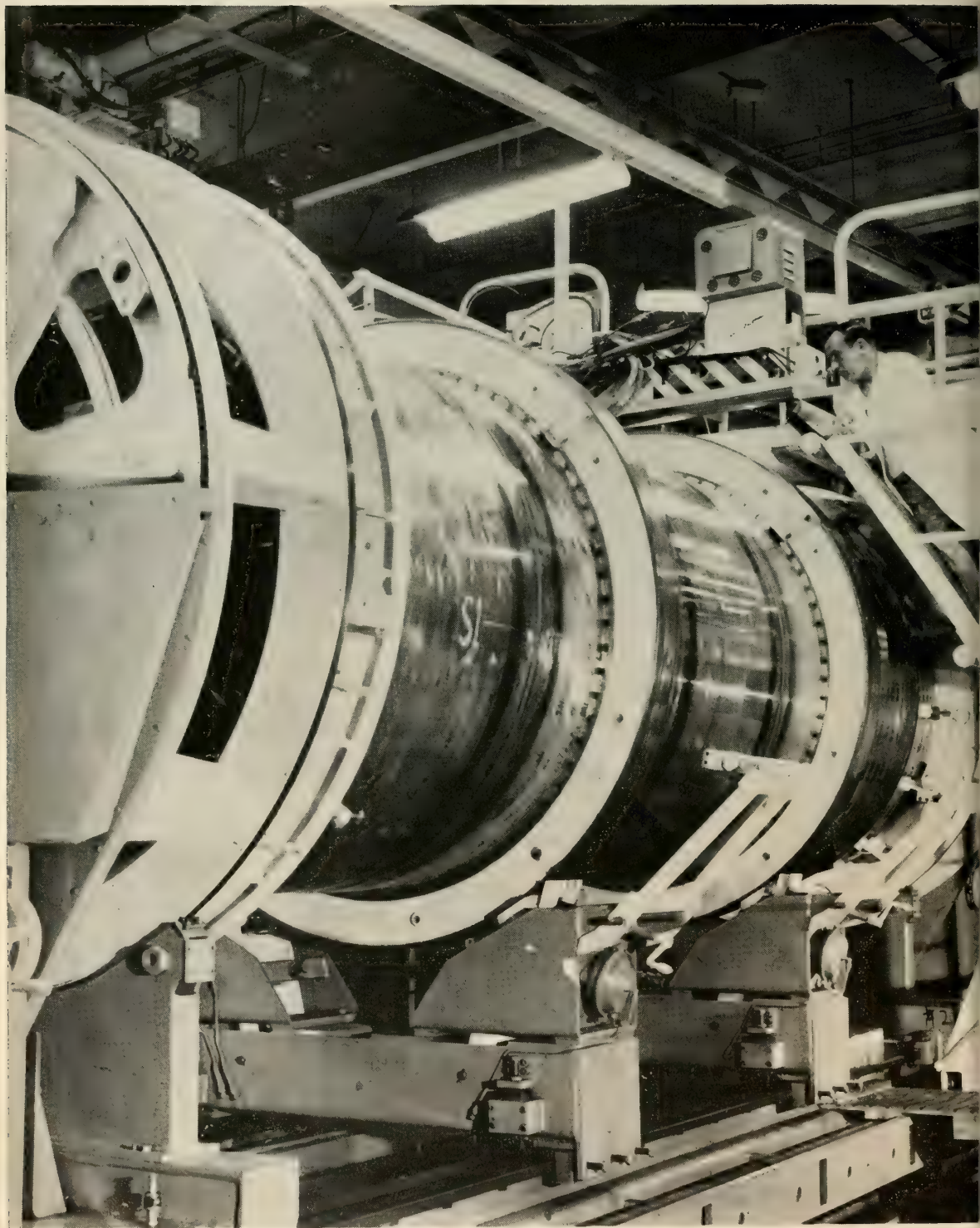
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#### Rocket Insulation

A light, low-cost, ambient-curing thixotropic insulation which can be sprayed on as rapidly as 40 lbs. per hour is available from Insulation Technology, Inc. The firm is also marketing a trowelable thixotropic rocket insulation formulated especially for use on rocket engines.

The sprayable insulation, a 100% solid organic compound containing no solvents, has a specific gravity of only 1.19. Any desired thickness can be sprayed without sag or slump on vertical surfaces with no waiting between coats, as with solvent dispersed materials. Its ambient temperature cure allows use on live motors.

The company's sprayable insulation, NRL 1126, has 25% elongation; trowelable insulation is more rigid, with a 5%

elongation. Samples 0.25-in. thick of each material, tested under erosive burning conditions with an oxyacetylene torch for 60 seconds, show a 20°F rise in back side temperature for the sprayable compound, and only 5°F for the trowelable rocket motor insulation material (NRL 1795).

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#### DC Power Supply

A high-stability, high-voltage d-c power supply featuring stability of 0.005% per hour, 0.02% for an 8-hr. period, is available from NJE Corp. Designated the HSV-5-20, it has an output of 50 to 5000 V and 0-20 MA. Input power is 105-125 V at a frequency of 55-65 cycles. Maximum ripple (mv) is 5 P-P. Static regulation is 0.01% maximum load for no-load to



full-load change at constant voltage, and 0.01% maximum line for line voltage change of 105-125 V AC at any constant load from zero to full load of rating.

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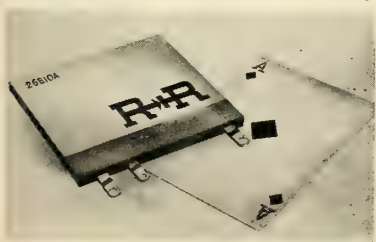
## Incremental Gaussmeter

An incremental gaussmeter, Bell Model 240, which uses a single Hall Effect sensing element and can be inserted in gaps only .020 in. long, is available from F. W. Bell, Inc. It combines all the features and capabilities of an earlier model, the Bell Model 120, while adding the advantages of incremental reading. The model will operate both as a conventional flux measuring and plotting instrument and as an expanded-scale, suppressed zero meter for observing small changes, or increments, in flux density. By means of a controlled feedback system, it can magnify a small change by a factor of 100 or more for detail study.

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## Selenium Rectifiers

To its recently announced line of flat, conduction-cooled selenium rectifiers, Radio Receptor Co., Inc. has added a line of "power flats" with similar advantages in applications requiring power-handling capacities up to 250 volt-amperes or even higher. Currently



available units include half-wave, doubler, and bridge configurations in single-phase or 3-phase circuits, in a single package for voltages up to 130 volts rms input and current outputs to 10 amperes dc., based on an allowable case-temperature of 150°F.

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## Precision Thermostat

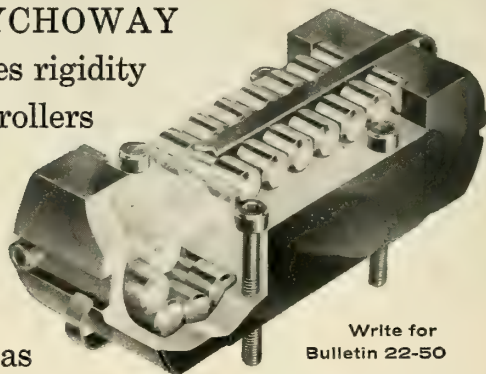
A subminiature snap-acting thermal switch is available from Thermel, Inc. Hermetically sealed, and especially resistant to vibration, shock and salt spray, this precision unit (Thermel #3001-2) meets or surpasses all applicable military specifications. Creeping and false cycling has been eliminated by an instantaneous "make and break" action. Insulation between the bi-metal disc and electrical contact arm insures control response from ambient temperatures only.

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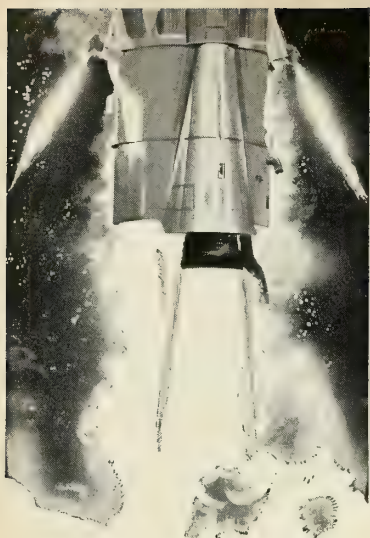


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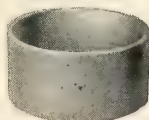
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**Otto G. Quanrud:** Former director of control and guidance at Rome Air Development Center and more recently with Pan American World Airways' Advance Planning Department, has been named assistant manager of Pan Am's newly created engineering management section called the Manned Lunar Landing Program. The section will direct and control the company's support of the Air Force Missile Test Center and NASA in development of the lunar launch range and conduct of operational phases.

**Willion G. Fallon, Jr.:** With Norton Company since 1943, rising to vice president and director in 1958, has been named vice president and general manager of Norton International Inc., the company's foreign operating subsidiary. **Allan F. Hardy, Jr.,** succeeds Fallon as general manager of Norton Company's Refractories Division. Also, **Louis J. Camarra** has been appointed vice president in charge of Latin American operations. He was formerly Norton International's vice president in charge of sales of abrasive products. These appointments follow by a week the announcement that **Dr. Wilfred F. L. Place** had been named vice president in charge of European operations for Norton International.

**Lt. Gen. Roscoe C. Wilson (USAF-Ret.):** Recently retired AF research chief, has been elected president and a director of Allied Research Associates, Inc. (M/R, Dec. 11, p. 12). Also elected to the board of directors were **Maj. Gen. Frederick L. Anderson, (USAF-Ret.), Paul V. Cusick, Henry W. Harding, William Barclay Harding, Donald L. Lucas, Lt. Gen. Donald L. Putt (USAF-Ret.), and Milo Vesel. Norman Buchbinder,** vice president-finance and administration, also is a director of the firm.

**Arthur C. Omberg:** Elected a vice president of the Bendix Corporation, responsible for operating three divisions—Bendix Mishawaka, Ind., Bendix Products Aerospace, South Bend, Ind., and Bendix Hamilton, Ohio—in addition to continuing to serve as general manager of the Mishawaka division. Omberg joined Bendix in 1944 as chief of research engineering.

**Paul G. Hensel:** The inventor and developer of the Doppler direction finders and the Doppler omnirange equipments has joined Electronic Communications,

Inc., as vice president of engineering. Hensel has been associated with Servo Corporation of America and with the Signal Corps Engineering Laboratories.

**Martin E. Zernick:** Appointed president of NYT Manufacturing Co., Alpha, N.J. Prior to joining the organization in 1958 as vice president of manufacturing, he was associated with General Electric Co. in various management capacities.

**Frank J. Skwarek:** Former vice president of Polarad Electronics Corporation's Defense Products Division, will head the new Electronic Systems Division covering research and development in such areas as electronic countermeasures systems, space navigation and communications equipment, precision instrumentation systems, antisubmarine warfare systems, aerospace ground support systems, and radio interference instrumentation. Prior to his present position, Skwarek was associated with General Electric Co., Westinghouse Electric Manufacturing Co., Sperry Gyroscope Co., Doelcam Corp., and Raytheon Manufacturing Co. He joined Polarad Electronics in 1951.

**Vern E. Leas:** Appointed director of military program management for the Univac Military department, Sperry Rand Corp. He will direct and supervise all major military programs at St. Paul, Minn., including computers for the *Titan, Nike-Zeus, Naval Tactical Data System, Mobile Atlantic Range Station* and advanced digital computer for aerospace applications. Leas had worked for IBM and as a self-employed electrical contractor prior to joining Univac.

**Robert E. Steinman:** Succeeding the late **Dr. S. Jacobsohn,** named president and elected to the board of directors of Gaertner Scientific Corporation. Steinman joined Gaertner in 1960 as administrative vice president. Previously, he was with Charles Bruning Co., Inc.

**Robert C. Loomis:** Formerly president of the Convair-San Diego division of General Dynamics Corporation, has joined American Electronics, Inc., as president and chief executive officer. Loomis will be in full charge of the company's multidivision operations located in Fullerton and Culver City, Calif.



## contracts

### AIR FORCE

\$19,962,250—General Dynamics Corp., for production of space boosters.

\$12,144,777—The Martin Co., Denver, for research and development for the *Titan II* program.

\$11,000,000—Radio Corporation of America, Moorestown, N.J., for work on the Ballistic Missile Early Warning System.

\$7,500,000—Massachusetts Institute of Technology, Cambridge, for work on a jointly-sponsored Air Force-Army-Navy-ARPA contract for performance of research and development in national defense.

\$6,000,000—Space Technology Laboratories, Inc., Los Angeles, for systems engineering and technical direction for the *Atlas*, *Titan* and *Minuteman* weapon systems.

\$5,000,000—Aerojet-General Corp., Sacramento, Calif., for research, development and related work for *Minuteman* motors (supplemental contract).

\$5,000,000—Page, River and Curran, Washington, for installation and checkout of the *Minuteman* control system at Ellsworth AFB, S.C.

\$4,495,132—American Bosch Arma Corp., for fabrication of missile guidance sets and related items and for installation and a checkout of the *Atlas* guidance system. (3 contracts)

\$4,000,000—Federal Electric Corp., Paramus, N.J., for installation of an interim tropospheric scatter communication system.

\$3,900,000—The Martin Co., Denver, for fabrication of *Titan II* missiles.

### ARMY

\$8,000,000—General Electric Co., Philadelphia, for work on Project *Advent* communication satellite vehicle.

\$5,000,000—Radio Corp. of America, for continuation of Project *DAMP*.

\$3,642,000—Raytheon Co., Lexington, Mass., for *Hawk* missiles and 21 maintenance test shots for the system (2 contracts).

\$1,800,000—Western Electric Co., Greensboro, N.C., for production of ground control equipment for *Nike-Hercules* missiles.

\$1,470,487—Pearce and Gresham, Decatur, Ala., for static-test facility for the *Saturn* vehicle.

### MISCELLANEOUS

\$15,000,000—to Vitroselenia, Italian company owned by Vitro Corp. of America and Selenia S.p.A., a Raytheon Company subsidiary in Italy, for design and management of installation of a missile test range on the island of Sardinia.

\$5,500,000—Arde-Portland, Inc., Paramus, N.J., from Thiokol Chemical Corp., for thrust vector control nozzles for first stage of *Minuteman* ICBM.

### NAVY

\$10,000,000—Lockheed Missiles and Space Co., Sunnyvale, Calif., for *Polaris* motors.

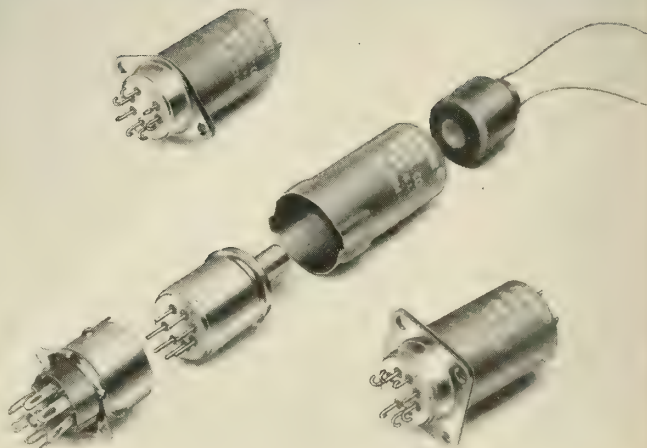
\$4,493,561—Hercules Powder Co., Wilmington, Del., for research and development in solid propellants.

\$4,000,000—Minneapolis-Honeywell's Aeronautical Division, St. Petersburg, Fla., for reference and pendulous gyroscopes for the *Polaris* guidance system.

missiles and rockets, December 18, 1961

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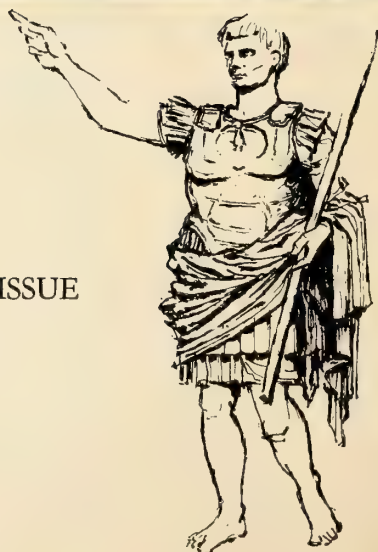
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*publishing date: March 26, 1962*

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Institute of the Aerospace Sciences,  
Smithsonian Institution, Washington,  
D.C., Dec. 18.
- Annual Meeting, American Association for  
Advancement of Science, Denver, Dec.  
26-31.
- Annual Meeting, American Statistical As-  
sociation, Roosevelt Hotel, New York  
City, Dec. 27-30.

### JANUARY

- Automotive Engineering Congress and Ex-  
position, sponsored by Automotive  
Engineers, Inc., Cobo Hall, Detroit,  
Jan. 8-12.
- 8th Annual Symposium on Reliability and  
Quality Control, Statler-Hilton Hotel,  
Washington, D.C., Jan. 9-11.
- 1962 Business Outlook Conference, spon-  
sored by the Los Angeles Chamber of  
Commerce, Biltmore Hotel, Jan. 10.
- 30th Annual Meeting, Institute of the  
Aerospace Sciences, Hotel Astor, New  
York City, Jan. 22-24.
- National Plant Engineering and Mainte-  
nance Show and Conference, Conven-  
tion Hall, Philadelphia, Jan. 22-25.
- Solid Propellant Rocket Conference, ARS,  
Baylor University, Waco, Tex., Jan.  
24-26.
- American Society of Mechanical Engi-  
neers, 2nd Symposium on Thermo-  
Physical Properties, Princeton, N.J.,  
Jan. 24-26.

### FEBRUARY

- Western Electronic Week and Pacific Elec-  
tronic Trade Show, Las Vegas, Nev.,  
and Los Angeles, Feb. 3-11.
- Winter Convention on Military Electron-  
ics, IRE, Ambassador Hotel, Los  
Angeles, Feb. 7-9.

### Classified

#### LOOKING FOR WAVEGUIDES?

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#### LOOKING FOR TRANSISTORS?

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International Solid State Circuits Confer-  
ence, Philadelphia, Feb. 14-16.

Tracking and Command of Aerospace  
Vehicles, Institute of the Aerospace  
Sciences, San Francisco, Feb. 19-21.

30th Annual Symposium on Nondestructive  
Testing of Aircraft and Missile  
Components (Southwest Research In-  
stitute), Gunter Hotel, San Antonio,  
Tex., Feb. 27-Mar. 1.

### MARCH

Institute of Radio Engineers, 8th Scintilla-  
tion and Semiconductor Counter Sym-  
posium, Washington, D.C., Mar. 1-3.

Armed Forces Communications and Elec-  
tronics Association, Cape Canaveral  
Chapter, Symposium, Cocoa Beach,  
Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), In-  
stitute of the Aerospace Sciences,  
Cleveland, Mar. 8-9.

1962 Symposium on Packaging of Chemi-  
cal Products, sponsored by Manufac-  
turing Chemists' Association, Inc., St.  
Louis, Mar. 13-14.

Goddard National Space Conference,  
sponsored by the National Rocket  
Club, Sheraton Park Hotel, Washing-  
ton, D.C., Mar. 14-16. (Goddard Me-  
morial Dinner on Mar. 16.)

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## A Letter From the Editor

**Y**EAR'S END provides a good opportunity to look back at the accomplishments of the missile/space industry during 1961 and ahead at its prospects and problems for 1962.

The industry can take pride in its achievements during a year in which a considerable head of pressure built up in regard to both manned and unmanned space flight programs, as well as the military programs for intercontinental and shorter-range missiles.

The year will go into the record books as the one in which the Russians, and the Russians alone, succeeded in placing men in earth orbit. We compliment the President and the National Aeronautics and Space Administration for the excellent sense shown in deciding not to pressure the Project *Mercury* team into a manned orbital flight attempt before year's end.

This magazine pointed out as early as July 24 that the manned orbital shot was almost certain to slip into 1962. Sound technical reasons existed for this. Any effort to high-pressure the program into a manned orbital shot in 1961 just to get it on the books in the same year as the Russians would have been a foolhardy and unnecessary risk.

The wonderful successes of the Shephard-Grissom suborbital *Mercury* flights and the initial *Saturn* firing made the year an outstanding one in the U.S. space program. With still a long way to go, we now are back in the race with the Russians with the avowed intent of catching and passing them. The year must be recorded as one in which our national leadership, for the first time, displayed the heartening support needed in the space race.

Letting of the prime *Apollo* contract was a major milestone in our developing space effort. At the beginning of the year, when another publication attacked the appointment of James E. Webb as NASA Administrator, we announced that we would withhold judgment on Mr. Webb until he had the opportunity to prove himself. NASA has expanded this year at a fantastic rate, as new responsibilities were heaped upon it by the President. Earlier in the year, as we reported, this resulted in considerable confusion in the space agency. Organization now is coming out of that chaos. Top-level NASA appointments have been sound, and the reorganized agency shows promise of being able to cope with the important tasks assigned to it. We think Mr. Webb is doing a good job in a difficult post.

Frequently overlooked but no less important than the more widely publicized manned space efforts are the growing number of unmanned scientific space probes and satellites. The year was an outstanding one in that respect. The *Discoverer* program continues on its successful path, *Scout* shots are mount-

ing in frequency, and the weather satellites already have proved their value.

The missile program moved well in 1961 and the Missile Gap—which many seem to have forgotten still exists in potential—shows signs of being closed under firm Department of Defense policy decisions.

The year 1961 also may turn out to be the one in which the dizzy spiral of "technical" meetings, association banquets and conventions finally reached its apogee. Our editorial stand for fewer, less extravagant and more worthwhile meetings drew an overwhelmingly favorable response from all parts of the industry and was followed by expressions of support from our colleagues on other trade magazines.

The recent action of Aerospace Industries Association in requesting its members to screen attendance of their employees at meetings, to set a high quality standard for reports, and to avoid costly exhibits could be a significant turning point. We applaud the AIA stand and urge the strongest possible industry support.

At the same time, we agree with AIA in its expression of support for strong technical and scientific societies. In this regard, we are quite pleased by the growing strength of the American Rocket Society, which enrolled its 20,000th member during 1961. Our compliments and best wishes for an even more successful 1962.

**L**ARGE PROBLEMS—in the patent field, in procurement practices and in obtaining recognition and financial support of important technical advances—lie ahead in 1962. We will keep attention focused on these.

We cannot state strongly enough our belief that a major military space effort must be initiated in the year ahead. The first step in this direction must be a well-financed expansion of the *Dyna-Soar* program. Military programs aimed at space reconnaissance and interception also need support. The industry must make every effort to convince Congress and the Administration of the importance to the nation of these programs.

In 1962, the U.S. will for the first time send a man into earth orbit. It will be a year in which we should not let our successes blind us or our setbacks discourage us. Overall, it should be, as the saying goes, a banner year for the missile/space industry.

In conclusion, we would like to add, from all of us on MISSILES AND ROCKETS to all of you, another old saying: Best wishes for a very Merry Christmas and a peaceful, Happy New Year.

William J. Coughlin



















